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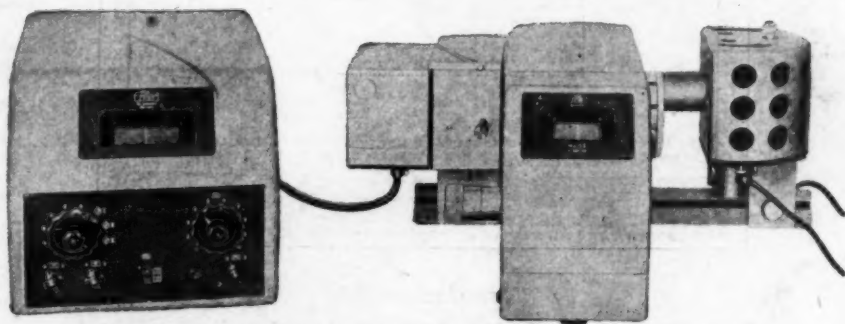
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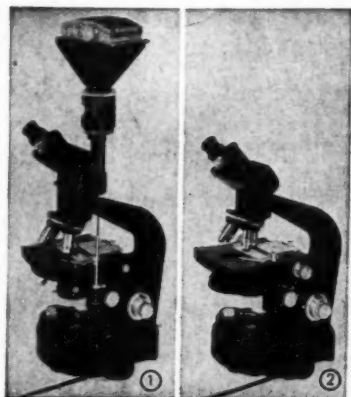
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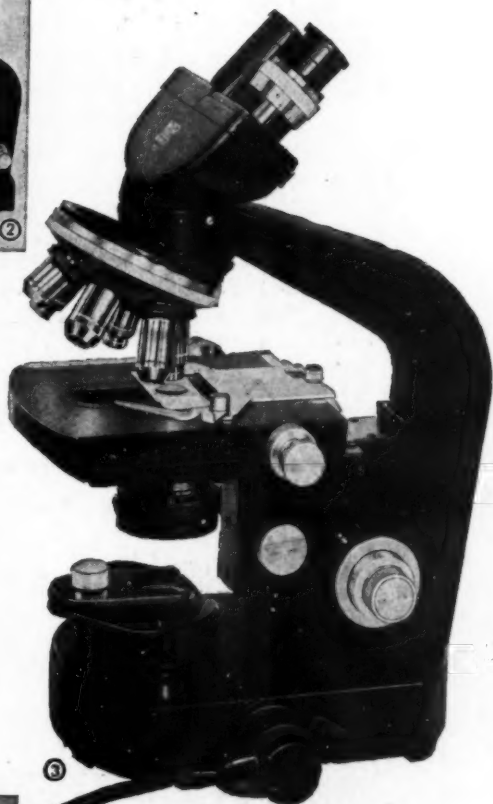


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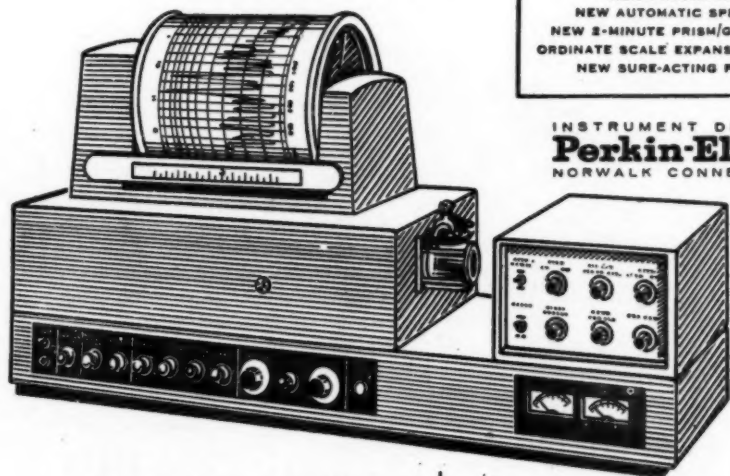
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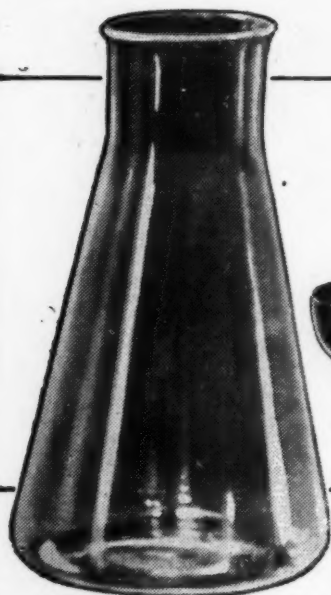
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RECENT ADVANCES IN INFRA-RED SPECTROSCOPY*

Dr. EARLE K. PLYLER

National Bureau of Standards, Washington, D.C.

INTRODUCTION

INFRA-RED spectroscopy has entered a new period of rapid progress as a result of the great technical advances that have been made in recent years in the instrumentation employed. These advances have been both with respect to increasing the resolving power of the spectrometer and with respect to mechanisation and speed of recording. Modern high-resolution infra-red spectrometer is the outgrowth of the earlier instruments used by such pioneer workers in this field as Rubens and Coblentz more than fifty years ago.

The present-day high-resolution grating spectrometer has a resolution of 0.02 cm^{-1} . This level of resolution has been possible by the development of lead sulphide detectors and high precision optical parts. Recent work on lead sulphide photo-conductive cell established it as a tool of exceptional sensitivity in infra-red spectroscopy. Its use has enabled a gain of at least ten times in resolution to be made, while the fast response of this detector has led to its application in infra-red for the rapid recording of spectra. The infra-red spectrometer which has been constructed in the Bureau of Standards has 10-inch gratings which are used double pass. The spectrum of the molecules is measured to a high precision by using the fringe system of a Fabry-Perot interferometer.

MOLECULAR DATA FROM INFRA-RED STUDY

Apart from its chemical and industrial applications the study of infra-red spectra, especially the high-resolution spectra, is of fundamental importance in obtaining data on the mechanics of simple molecules. Vibrational spectra are the only source of our knowledge of the inter-atomic forces which hold molecules together and govern the relative motions of their atoms. In recent years high-resolution spectra of many molecules have been measured and the molecular dimensions determined. One recognised method of checking the assignment of vibrational frequencies and obtaining more precise

information on inter-atomic distances and angles in molecules is to study the infra-red spectra of deuterated molecules. The replacement of hydrogen by deuterium in molecules containing hydrogen results in specific vibrations moving to lower frequencies, thus serving to check and confirm assignments, evaluate more distances and check force fields. For example the spectrum of ethylene and totally deuterated ethylene made it possible to obtain an exact value for the angle of the CCH atoms. It was found to be 116.5° instead of the previously accepted value of 120° . Similar measurements have been made on methane and deuterated methane. One interesting feature of the methane spectrum is the large number of lines in the bands when high resolution is employed. In the region between $2,400$ and $3,200\text{ cm}^{-1}$ several bands were observed and $2,600$ lines of methane were measured. In view of the fact that there are a large number of lines to be recorded and also because of the high dispersion involved considerable time is required to record the spectra. For the methane spectrum between $2,400$ and $3,200\text{ cm}^{-1}$ 12 hours of time and 480 ft. of recorder paper were needed to observe the spectrum.

PRECISION STUDIES OF DIATOMIC MOLECULES

Recently some attention has been given to the precision study of diatomic molecules. The carbon monoxide spectrum measured to a high precision (error 1 part in a million) has enabled the velocity of light to be determined to a degree of accuracy never attempted before by this method. The velocity is calculated by combining the wave numbers obtained from infra-red measurements with the frequency measurements from microwave data. The value of the velocity of light obtained by this method was $c = 299793 \pm 3\text{ Km./sec.}$ This value agrees closely with the values obtained by other methods.

Other diatomic molecules have been measured to a high precision so that there are now available a number of accurate wave number values which are useful for the calibration of spectrometer. The region from 650 to $4,000\text{ cm}^{-1}$ (2.5 to 16μ) has now about $1,000$ calibration wave numbers for use of spectroscopists in many laboratories. Work is in progress for extending calibration from 16 to 100 microns.

* This article is based on the lecture given at the Symposium on "Vibration Spectra of Molecules and Crystals" at the 26th Annual Session of the Indian Academy of Sciences, held in Madras, on December 27, 1960.

SPECTRA OF TRIATOMIC MOLECULES

Researches have been carried out on the spectra of several triatomic molecules. Infra-red spectra are the best means of determining the structure of small molecules. For example, nitrous oxide (N_2O), carbon dioxide, carbon disulphide, hydrogen cyanide are linear molecules, while H_2O , NO_2 , SO_2 have a triangular structure. The difference in the spectra of these two classes of molecules is great when measured under high resolution. The linear molecules, except for a small convergence, have equally spaced lines while the nonlinear molecules have a very complex spectrum. For example the ν_1 and ν_3 bands of H_2O in the region of $3,500\text{ cm}^{-1}$ have a spectrum which has been resolved into 2,000 lines. The analysis of molecules of low mass is not difficult except for the solution of the interactions which displace the spectral lines from their normal position. The Fermi interaction is the most common type.

Under low resolution a linear molecule has a very simple spectrum. With high resolution all the Q branches can be resolved and hot bands are observed overlapping the main band. In addition there are usually isotopic bands in the same region and the resultant spectrum is somewhat complex. However, with sufficient resolution the different bands can be separated and a fairly complete analysis of the spectrum can be made. There are now known about 90 bands of N_2O arising from different levels and a fairly complete form of the potential function can be obtained. It is now possible on the basis of measurements of the last five years to give a good description of the energy levels of many triatomic molecules.

Usually the spectra of linear and of spherical top type molecules show approximately evenly spaced lines. With high resolution the difference between the spectra becomes apparent since the spherical top molecules, such as CHD_3 , show K type structure. When the K structure is resolved there is possible to form many equations for determining the molecular constants and the precision of the values is increased.

INFRA-RED AND RAMAN SPECTRA

Study of high-resolution spectra in the region from 2 to 10μ has added much information to the subject of molecular structure. With the information obtained from the Raman spectra as a complement to the infra-red spectra the subject has become the best method for obtaining information on the structure of molecules and their energy levels. Certain symmetry motions of the atomic centres are inactive in the infra-

red spectrum and only from the Raman spectrum can these vibrations be observed. The use of infra-red spectra as a means of analysis has replaced many normal chemical methods. The growing importance of infra-red and Raman spectroscopy in industry is evidenced by the increasing number of industrial laboratories which employ this as a tool to further their research programmes. Large numbers of infra-red spectrometers are used in the chemical industrial firms. One chemical firm in U.S. has over 100 infra-red spectrometers throughout its operation. Infra-red analysis is used extensively in the petroleum industry and in organic chemical plants.

FAR INFRA-RED SPECTRA

The Raman spectroscopy, because of its greater technical facility, has contributed more than infra-red absorption spectrometry to molecular spectra studies in the far infra-red. The Raman Spectra were the only means of measuring low lying vibrations (25 to 400 cm^{-1}) of bands until a few years ago. Now there are available infra-red spectrometers which will measure spectrum in this region. By the use of prisms of CsBr and CsI infra-red spectra can be measured as low as 56μ (190 cm^{-1}) and with grating instrument the spectra can be measured to 400μ (25 cm^{-1}). The spectrometers with CsBr and CsI prisms are only slightly different from the conventional NaCl instrument. However, there is the greater problem of removing stray radiation. With the small grating instruments for the far infra-red the higher orders of the grating must be removed. This is usually accomplished by the use of reflection filters. The reflection filters may be restrahlen plates or roughened mirrors. Black polyethylene has been found to be an excellent transmission filter. The Golay cell is a very good detector for the far infra-red and a high pressure mercury arc in quartz makes a good source.

In the far infra-red spectrum there are three types of researches which are being carried out. They are (1) the measurement of crystal spectra; (2) pure rotation spectra, and (3) vibration and torsional bands. On account of the high level of activity in researches of the solid state there is a considerable demand for measurement in the far infra-red. In these measurements it is usually desirable to study the spectrum at different temperatures. In some cases temperatures as low as those of liquid helium and liquid hydrogen are used. Marked changes of great significance are observed in the spectrum at such low temperatures.

At present considerable interest is shown in the findings of the torsional vibrations in compounds such as substituted ethane (for example CHBr_2 , CH_2Br). These bands usually fall between 100 and 300 cm^{-1} and are easily observed with a small grating spectrometer.

CONCLUSION

In conclusion it appears that Raman and infra-red spectra are the two most important tools

for the study of molecular spectra. With present-day resolution information may be obtained by the spectra of heavy molecules which was previously thought impossible. Also, the importance of infra-red spectra in astrophysics is now beginning to be recognised. Present indications are that infra-red researches will be important and will be in high activity for many years.

INDIAN ACADEMY OF SCIENCES : XXVI ANNUAL MEETING

THE Twenty-Sixth Annual Meeting of the Indian Academy of Sciences was held in Madras on 27, 28 and 29 December 1960, at the invitation of the Madras University. The inaugural function was held in the Senate Hall of the University before a large gathering of distinguished Guests, Fellows and Delegates. Sir A. Lakshmanaswamy Mudaliar, Vice-Chancellor of the University, in his Inaugural Address spoke on the impact of fundamental sciences on applied science. The days are long past, he said, when the different disciplines in science were treated as isolated and unconnected units and the more one sees of the progress of science in general, the more is one convinced that all scientific work is interdependent, that there can be no question of science being looked upon in separate compartments. Science in its broadest sense is one and indivisible. In this connection Sir Lakshmanaswamy referred to his own profession—medicine—which owed its greatest progress during the last half a century to the knowledge gained by the great discoveries in many fields of fundamental sciences like physics, chemistry, zoology and botany. He concluded by saying that the artificial distinction sought to be made between fundamental and applied science is unreal and will not lead to progress. A happy blending of both aspects has so far given us results which encourage us in the hope that more and more benefits of science will accrue to humanity at large.

Sir C. V. Raman, President of the Indian Academy of Sciences, in his Presidential Address on the "Physiology of Vision" described in detail the methods and results of the simple but extremely powerful technique which he has invented and which enables one to see the retina of his own eyes in the act of functioning. The observer sits facing a brightly lit white screen and views it through an appropriate colour filter held in front of his eye. After a sufficient interval of time, he fixes his vision on some

particular point on the screen and then removes the filter. An enormously magnified picture of the retina then appears on the screen, the nature of which depends very much on the particular colour filter used. The explanation of the phenomenon is that the rays of the spectrum which in the first instance are absorbed by the filter, suddenly impinge on the retina when the filter is removed, and excite localised sensations over its different areas. These sensations project themselves on the observing screen as an enlarged image of the retina.

By correlating the absorption spectra of the filters used with the pictures of the retina perceived by the observer, it has been ascertained that the retina contains three visual pigments whose absorption spectra lie in different regions of the spectrum. The three pigments have been identified as (1) Xanthophyll which absorbs light in the blue and violet sectors of the spectrum; (2) Ferroheme which exhibits a powerful absorption in the green sector located at the same position as the maximum of visual luminosity in the spectrum and (3) Ferriheme whose absorption is weaker than that of ferroheme, but extends much further towards longer wavelengths and sensible up to the extreme red end of the spectrum.

Sir C. V. Raman then proceeded to show how it is possible to connect the observed variations of luminosity and colour in the spectrum with the absorption characteristics of the visual pigments. On the basis of the new theory proposed a natural and satisfactory explanation could be given for chromatic and achromatic sensations and also for defective colour vision. Chromatic sensations arise when only two of the three visual pigments function, and achromatic sensation arises when all the three visual pigments function in appropriate strengths. The existence of both ferroheme and ferriheme as visual pigments in the retina presupposes that there is a biochemical mechanism which determines the proportions in which they are normally

present. Any deviations of the mechanism from normality would produce an imbalance in the ferroheme—ferriheme ratio in the retina which will account for the various types of defects in colour vision.

The second and third days of the session were devoted to scientific meetings in Section A (Physical Sciences) and Section B (Biological Sciences). Dr. S. Bhagavantam was the Chairman for meetings in Section A, and Dr. K. Ramiah was the Chairman for Section B.

In Section A, there was a Symposium on "Vibration Spectra of Molecules and Crystals" in which there were three invited one-hour talks. The first talk was given by Dr. S. Bhagavantam on "Molecular Vibrations in Theory and Experiment". The second talk was by Dr. Earle K. Plyler on "Recent Advances in Infra-Red Spectroscopy" (see p. 1). The third talk was by Sir C. V. Raman on "The Vibration Spectra of Crystals in Theory and Experiment".

In the scientific meetings in Section A, the following half-hour papers were presented (1) "The Structure of Collagen" by Prof. G. N. Ramachandran; (2) "Masses of Elementary Particles" by Dr. Alladi Ramakrishnan; (3) "Coherence Properties of Light" by Dr. S. Pancharatnam; (4) "Molecular Structure" by Dr. K. S. Viswanathan; (5) "Electro-deposition" by Dr. K. S. G. Doss; (6) "The Crystal Structure of Ehitamine" by Dr. S. Ramaseshan (see p. 5); (7) "Raman Effect Studies" by Dr. K. Venka-

teswarlu; and (8) "Mechanism of Chemical Reactions in Solution" by Prof. S. V. Ananthakrishnan.

In the scientific meeting in Section B, the following half-hour papers were presented; (1) "The Genetics of Rice" by Dr. K. Ramiah; (2) "Photosynthesis" by Prof. T. S. Sadasivan; (3) "Structure and Synthesis of Tylophorine" by Prof. T. R. Govindachari; (4) "Biochemical Research with Corcyra" by Prof. P. S. Sarma; (5) "Cellulose Formation by Micro-organism" by Dr. K. Ramamurti; and (6) "Leptocephali in Indian Waters" by Sri. R. Velappan Nair.

There were two public lectures in the evening of the 28th and 29th. The first lecture was on "The Story of the Earth" by Dr. S. Bhagavantam and the second was on "Music and Musical Instruments" by Sir C. V. Raman.

On the 30th December there was an excursion to Mahabalipuram famous for its monolithic architecture and rock carvings of the 7th century A.D.

At the business meeting of the Academy held on December 27, the following were elected to the Academy: *Honorary Fellows*: Professor Theodore Von Karman, France; Professor San-ichiro Mizushima, Japan; Professor Axel Hugo Teodor Theorell, Sweden.

Fellows: Dr. Jacob Chandy, Dr. V. S. Huzurbazar, Dr. T. N. Khoshoo, Dr. S. Krishnaswamy, Shri K. Nagabhushana Rao, Dr. M. Santappa, Dr. A. P. Subramaniam.

INDIAN SCIENCE CONGRESS

THE Forty-Eighth Session of the Indian Science Congress was held in Roorkee from January 3-9, 1961. Dr. Rajendra Prasad, President of India, inaugurated the session. In his Inaugural Address Dr. Rajendra Prasad expressed the hope that science would continue to serve mankind and that the new knowledge man has acquired will be used for the conquest of want and eradication of human suffering. Stressing on the importance of spiritual values Dr. Rajendra Prasad said that it had become increasingly clear that the only way to harness the discoveries of science into the service of man was by developing a sense of values, call it moral or religious or spiritual. Without it, all the advance and the consequent material progress, howsoever good in itself, would ever continue to hold before mankind the threat of extermination.

Dr. N. R. Dhar, General President of the Session, in his Presidential Address on "Nitrogen Problem" dealt with the subject of soil fertility from the point of view of the application of

nitrogenous fertilizers to the land. Dr. Dhar claimed that "industrial nitrogen is unable to cope with world food production but organic matter aided by calcium phosphates and light can meet the situation and improve land fertility permanently".

The papers presented at the different sections were read and discussed in the sectional meetings presided over by their respective Presidents. The thirteen sections and their Presidents were as follows: 1. Mathematics (Dr. R. S. Varma), 2. Statistics (Dr. G. R. Seth), 3. Physics (Dr. S. R. Khastgir), 4. Chemistry (Dr. T. N. Ghosh), 5. Geology and Geography (Shri W. B. Metre), 6. Botany (Dr. P. N. Mehra), 7. Zoology and Entomology (Dr. S. P. Ray Chaudhuri), 8. Anthropology and Archaeology (Dr. P. C. Biswas), 9. Medical and Veterinary Sciences (Dr. A. K. Hazra), 10. Agriculture (Dr. B. L. Chona), 11. Physiology (Dr. D. N. Mullick), 12. Psychology and Education (Dr. N. Mukherji), and 13. Engineering (Dr. H. N. Das Gupta).

THE STRUCTURE OF ECHITAMINE IODIDE

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From the Department of Physics, Indian Institute of Science, Bangalore-12

ECHITAMINE ($C_{22}H_{29}O_4N_2$) the major alkaloid derived from the bark of *Alstonia scholaris*, has been attracting the attention of the organic chemist in recent months and its structure has been the subject of some controversy.¹⁻⁶ The determination of its X-ray, crystal structure was undertaken by the present writers at the instance of Prof. T. R. Govindachari who was kind enough to prepare for them the quaternary iodide and the chloride ($C_{22}H_{29}O_4N_2I, Cl$). Goodson and Henry⁷ report that the iodide crystallises in the anhydrous state while the chloride crystallises as "stumpy prisms" with one molecule of water when crystallised slowly from water but as long anhydrous needles when crystallised rapidly. Chemical analysis of the iodide by Prof. Govindachari gave the formula $C_{22}H_{29}O_4N_2I$. No analysis was done on the chloride but the needle shape of the crystals was taken to indicate the absence of any water of crystallisation.

Rotation and Weissenberg photographs gave the space group to be $P2_12_12_1$ with the following axial dimensions in Angstrom units:

	<i>a</i>	<i>b</i>	<i>c</i>
Echitamine iodide	18.45	13.83	8.48
Echitamine chloride	17.29	14.97	7.94

The measured value of the density in the case of the iodide ($d = 1.583$) gave four molecules in the unit cell and confirmed the anhydrous nature of the crystals. The density of the chloride was not determined. The differences in the axial dimensions suggest that the isomorphism between the two compounds may not be exact.

Intensity data were collected for the *hko*, *hkl* ($L = 1$ to 5) and *hol* reflexions using the multiple film technique of Robertson and the intensities were accurately measured visually using calibrated scales. In the *hko* zone there were 196 reflexions of measurable intensity for the iodide and 166 for the chloride. The L.P. and absorption corrections were applied and the approximate scale factors determined by the Wilson method.

An *hko* Patterson projection gave the iodine position to be $x = 0.067$, $y = 0.190$ in fractional co-ordinates. By the heavy atom and the isomorphous replacement method the phases of 70 reflexions for the iodide and 52 reflexions for the chloride could be deduced with some certainty. However, it was decided to proceed only with the solution of structure of the iodide. A Fourier projection using these 70 amplitudes not only confirmed the iodine position but also showed a large number of other peaks. From the structure factor computation made on putting 17 carbon atoms at the peaks in the Fourier, 66 additional signs could be assigned. A Fourier with these terms included showed better resolution, a phenyl and a five-membered ring being easily distinguishable. The iterative process of Fourier synthesis was continued till all the 28 atoms of the molecule (excluding the hydrogens) could be put in at the Fourier peaks. The structure factor calculations with all the atoms assumed to have the scattering factor of carbon gave the signs of about 169 reflexions and the R factor was 0.28.

A subtraction Fourier projection with the temperature corrected iodine contribution removed showed very much better resolution and with the movement of the atoms to the peaks the R-factor came down to 0.22. A Difference-error synthesis indicated that six atoms had been placed in wrong positions. On moving them to high positive regions not only did the R-factor come down to 0.19, but most of the "bad" reflexions became very much better. This was followed by two subtraction Fouriers and one difference projection and the subsequent structure factor calculation gave the phases of 192 out of 196 observable reflexions. Of the 23 reflexions whose phases were obtained in the later stages of the iterative process there were a few of medium intensity (e.g., $210: F_0 = +21.5$, $F_1^{calc} = -35$) whose signs came out opposite to those deduced by the heavy atom method. These had a considerable effect in not only resolving the peaks in the iodine removed Fourier but also in completely suppressing many spurious peaks.

The iodine removed *hko* Fourier projection is given in Fig. 1. A very small peak persists at the iodine position but each one of the 28

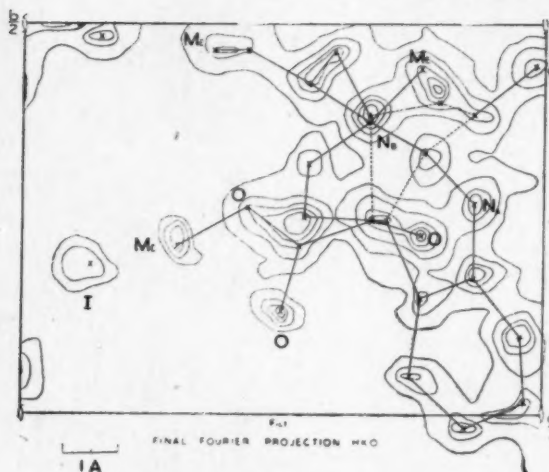


FIG. 1

heavier atoms of the molecule could be easily identified. The structure factor calculation gave an R-factor of 0.15 for 196 observed *hko* reflexions. The unobserved reflexions also calculated quite low.

The configuration of any molecule can be assigned without ambiguity only if its crystal structure has been solved in at least two projections. However as the iodine subtracted *hko* projection (Fig. 1) shows very good resolution it should be possible to deduce the molecular structure from it making use of some of the well-established chemical data about the compound.

It became increasingly clear during the progress of this work that the structure (I) sug-

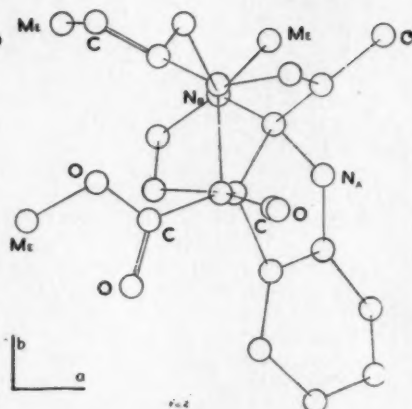
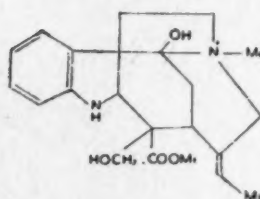


FIG. 2

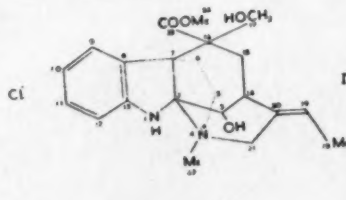
gested by Conroy⁴ or its modification due to Robinson *et al.*⁵ are incompatible with the Fourier projection. In the *hko* projection (Fig. 1) the following features may be clearly discerned: (1) A phenyl ring with a five-membered ring fused to it; (2) this five-membered ring is fused on to two other rings—one five-membered and one six-membered boat-

shaped ring (dotted lines in Fig. 1)—along a common bond; (3) the carbomethoxy group is attached to the six-membered boat at the equatorial position; (4) the heavy peak at the centre of the first five-membered ring is due to two atoms and is therefore presumably the carbon and the oxygen of the CH_2OH . This group is attached to the same carbon atom of the boat as the carbomethoxy group; (5) an oxygen atom (probably the OH group) is attached to the opposite point of the boat.

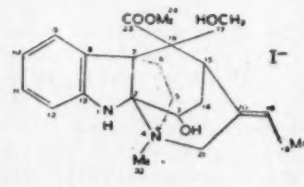
The $\text{C}=\text{Me}$ can also be identified although



I



II



III

gested by Conroy⁴ or its modification due to Robinson *et al.*⁵ are incompatible with the Fourier projection. In the *hko* projection (Fig. 1) the following features may be clearly discerned: (1) A phenyl ring with a five-membered ring fused to it; (2) this five-membered ring is fused on to two other rings—one five-membered and one six-membered boat-

the manner in which it is joined to the main structure is not so clear. For deducing this a model given by II which satisfies all the five points mentioned above was first tried. The model appeared to have the further merit in having (a) the $\phi\text{-N-C-N}$ system advocated by Govindachari¹ and Birch⁶; (b) the same number of five-membered and six-membered

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rings as in the structure due to Conroy and Robinson *et al.* When the three-dimensional model was made it was found that it could explain all but two of the peaks in the Fourier projection.*

However, when the bond connecting C_{20} to C_{14} was shifted to $C_{20}-C_{15}$ as in III (making the lower six-membered ring of II into a seven-membered ring), all the atomic peaks could be most satisfactorily explained. It appears therefore that III is the most probable structure of echitamine iodide. Figure 2 gives the identification of the Fourier peaks in Fig. 1, according to the structure III. The solution of the *hol* projection and the refinement of the parameters are in progress.

The authors wish to record their grateful thanks to Prof. T. R. Govindachari of the Presidency College, Madras, for preparing the compounds and for the invaluable discussions they had with him. Thanks are due to Prof. D. K. Banerjee and Mr. G. Bagavant of the Indian Institute of Science with whom the authors were in constant consultation. Thanks are also due to Prof. R. S. Krishnan for his very kind interest in this problem.

* At this stage Prof. T. R. Govindachari intimated one of us (S. R.) that he had received a letter from Prof. J. Monteath Robertson stating that he had solved the structure of echitamine bromide and that it corresponded to III. Model III was tried only after the receipt of this information.

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Note added in Proof: Prof. J. M. Robertson has kindly informed us that the compound used by him for solving the structure was echitamine bromide with a molecule of methanol as solvate.

VARENNA SUMMER SCHOOL ON RADIOFREQUENCY SPECTROSCOPY

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THE "Enrico Fermi" International School of Physics sponsored by the Italian Physical Society, under the joint auspices of the Italian Ministry of Public Instruction and the Italian National Council of Research, held its Seventeenth International Summer School Course entitled "Topics on Radiofrequency Spectroscopy" at the Villa Monastero, Varenna, on Lake Como from 1st August to 17th August 1960. Professor A. Gozzini (Pisa) was the Director of this Course.

The subjects discussed in the School can be broadly classified under the following headings: (1) Radiofrequency spectroscopy of optically oriented atoms; (2) Study of nuclear and atomic ground states by atomic beams; (3) Masers and maser spectroscopy; (4) Double irradiation in magnetic resonance. The lectures were delivered in French and in English.

The Course commenced with a general exposition by Professor Brossel (Paris) on optical pumping. The subject of optical methods in magnetic resonance was discussed in a series

of twelve lectures by Professor A. Kastler, Professor J. Brossel, Dr. C. Cohen-Tannoudji and Dr. A. D. May (all from Ecole Normale Supérieure, Paris) and Professor T. Skalinski (Warsaw). The aspects of optical pumping which covered these lectures were (i) the experimental methods for optical pumping and the detection of nuclear magnetic resonance; (ii) a theoretical discussion of the phenomenon of coherence in optical resonance study of the fundamental states and optically excited states of atoms; (iii) measurement of lifetimes of excited states; (iv) study of collisions; and (v) investigations of excited states produced by electronic bombardment.

Professor W. A. Nierenberg (Berkeley) dealt with the study of atomic and nuclear ground states by atomic beams. After a heuristic discussion of the hyperfine Hamiltonian, the Breit-Rabi diagram and the atomic magnetic moment, he described the computational methods for determining the parameters a , b , g_I and g_J . The results so far obtained on Pu^{239} , Pu^{233} , Tm^{170} and Pa^{233} were presented,

Professor C. H. Townes (Columbia), Professor K. Shimoda (Tokyo), Professor B. Elschner (Jena) and Dr. Ali Javan (Bell Labs.) conducted the lectures on Masers and Maser Spectroscopy. The noise figures of maser amplifiers, the limits on electromagnetic amplification due to complementarity and the phase and frequency fluctuations in a maser oscillator were discussed by Townes. A travelling wave solid state maser developed by Bell Telephone Laboratories was described. The application of masers to generation, amplification and detection of very high frequencies in the optical and infra-red region were discussed and a report on the recently developed infra-red and optical masers was given. The lectures delivered by Professor Shimoda covered the following aspects of beam maser spectroscopy: (1) a discussion of the sensitivity and line-width in both conventional and beam maser spectroscopy in the microwave region; (2) the experimental results that have been obtained using maser spectrometers on (a) the magnetic hyperfine structure and the Zeeman effect of the ammonia spectrum, (b) the low frequency rotational spectra of formaldehyde at 4-5769 Mc./s.; (3) three-level maser spectroscopy of gases with OCS and HDCl as examples and (4) the applications of the three-level maser for ultramicrowave spectroscopy.

Professor B. Elschner's exposition on solid state masers dealt with Bloembergen's theory of the three-level maser action of a crystal with paramagnetic ion; Javan's theory of three-level masers; applications of these theories to ruby masers; a two-level maser attained by adiabatic fast passage and the experimental results obtained on a Raman-type maser.

Dr. Javan described his attempts at the Bell Telephone Laboratories to attain negative temperature in atoms by electron impact.

Professor A. Abragam's (Saclay) exposition consisted of a general formalism for the explanation of double irradiation effects in magnetic resonance. The formalism employs spin density matrices and takes into account the interactions that lead to the phenomena observed. Equations were developed for (1) interaction between electronic and nuclear spins; (2) calculation of line-widths; (3) spin diffusion; (4) Overhauser effect in liquids, metals and semiconductors; (5) experiments at elevated and very feeble magnetic fields; (6) relaxation mechanisms and measurements of earth's fields; (7) the solid effect; (8) electronic and nuclear double resonance (endor). Dr. J. Winter (Saclay) gave a theoretical description for multiple quantum resonance absorption. One of the most interesting results reported by the Saclay School was the observation of nuclear resonance of Co^{59} and Fe^{57} in ferromagnetic substances with no external magnetic fields. The resonance absorption arises from the levels split by the local fields of the order of 100,000 gauss, whose intensity could be arrived at from the Mössbauer effect. The surprisingly large intensity of absorption in Fe^{57} has been explained in terms of the Bloch walls being modulated by the applied r.f., thereby augmenting the intensity of the r.f. field at the site of the nucleus.

Among the other subjects discussed in the School were electric dipolar transitions of two quanta in a gas by A. DiGiacomo (Pisa) and the applications of radiofrequency spectroscopy to frequency and time standards by J. De Prins (Neuchatel).

CULTIVATION OF ALGAE IN HEAVY WATER

AN exhibit demonstrating the cultivation of green algae in heavy water was shown by Argonne National Laboratory, Argonne, Ill., at the Seventh International Soil Science Congress at the University of Wisconsin.

This exhibit demonstrated, for the first time, how algae can grow in an environment where nearly all of the atoms of hydrogen have been replaced by atoms of the rare isotope deuterium.

The exhibit consisted of a transparent plastic container 24 in. in diameter with a rotating paddle-wheel agitator. Nutrient, light, and a

mixture of 5% carbon dioxide and 95% nitrogen gas were provided. The algae were kept cooled to room temperature.

Algae grown in heavy water synthesize organic compounds containing only deuterium in positions normally occupied by hydrogen. The deuterated compounds, for example, glucose, can then be fed to other plants and animals in research to determine the effects of heavy hydrogen on metabolism. The preparation of many of these synthetic compounds by other laboratory methods is difficult, often impossible.

LETTERS TO THE EDITOR

DIURNAL VARIATION OF F_1 REGION
DRIFTS AT WALTAIR

HORIZONTAL drifts in E and F_2 regions of the ionosphere at different latitudes have been studied by several investigators. Except for a few observations taken at Mayaguez by Donald Yerg¹ and at Cambridge, Mass., by Kurt Toman,² the F_1 region drift measurements have not been reported so far from any other station. In a recent communication³ the authors reported results of F_1 drift measurements taken at Waltair at 0900, 1200 and 1500 hours. The present communication contains the results of F_1 region diurnal study carried out for all the four seasons of the year, during the period of 1956-58, at Waltair, using the spaced receiver method of Mitra.⁴

The operating frequency for each observation was decided taking into account the critical frequencies of E and F_1 regions. On some days during the early morning and late evening hours the f_oE and f_oF_1 values were so close that it was not possible to get reflections from F_1 region alone, without partial reflections from E region. For this reason F_1 drift measurement could not be taken for all the twelve hours during the interval 0600 to 1800 hours I.S.T. in all the four seasons. In summer the occurrence of E_s presented some difficulties reducing the volume of diurnal data. In view of these, the operating frequency had to be different on different days and generally lay between 4.0 Mc./sec. and 4.8 Mc./sec. The virtual height of F_1 reflection varies between 230 and 260 Km. In order to minimise the effect of lower region on the pulses reflected from the F_1 region, care was taken to see that the operating frequency for F_1 region was sufficiently higher than the critical frequency of E region.

Considering first the variation of drift speed, it is observed that there is no significant change in the magnitude of F_1 drift from hour to hour except that at noon time the drift speed may be said to be a little higher than at other hours.

The curve depicting the diurnal variation of F_1 drift direction for the four seasons is shown in Fig. 1. The drift direction in degrees East of North is plotted against the time at which the observation was taken. It is interesting to note that in winter the F_1 drift was directed towards SW throughout the duration of 0800

to 1600 hours when observations were possible. In all the other seasons the drift direction was towards NE in the morning and evening hours. It can also be seen that the times at which the drift direction changes from NE to SW in the morning and SW to NE in the evening as well

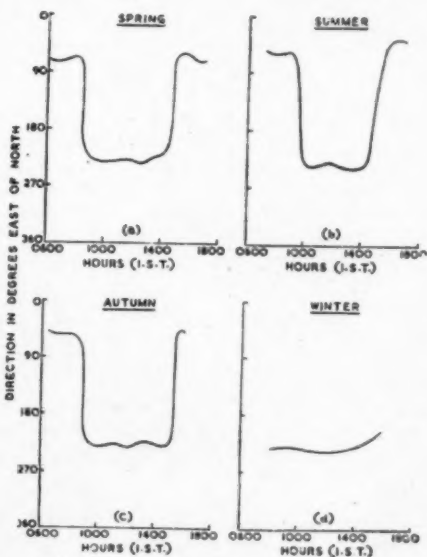


FIG. 1

as the duration for which the drift was directed towards SW shows definite seasonal variations. For instance in Summer the drift changes from NE to SW after 0930 hours and changes back to NE by about 1500 hours, the duration for which it was directed towards SW being about four hours which is the shortest compared to the duration of eight hours or more for Spring and Autumn. Even though the duration, for which F_1 drift was directed towards SW, was nearly the same for the Spring and Autumn seasons the transition time from NE to SW in the morning and SW to NE in the evening occurs about half an hour later in the Autumn compared to the Spring season. The drift directions observed at 0900, 1200 and 1500 hours from this diurnal study are in general agreement with the directions reported by the authors³ from an analysis of records taken at 0900, 1200

and 1500 hours. Thus it may be seen that in all seasons except winter the F_1 drift direction shows a systematic variation.

For all the four seasons the EW and NS components are plotted separately with a view to see if there is any phase difference between the two components. It was found that the variation of the EW and NS components is similar both in magnitude and direction except in Summer when they showed a small phase difference. Thus it seems that at this low latitude station there is no systematic clockwise rotation of drift vector from hour to hour. On the other hand the drift vector shows a rapid reversal of direction twice in a period of 12 hours. From an analysis of about 26 observations Donald Yerg¹ found that at Mayaguez the mean drift for the F_1 region was towards NW in the morning and changes to NE by late afternoon, through North. Thus the F_1 drift direction at noon for Mayaguez is opposite to the direction obtained by the authors for Waltair, though the directions in the morning and late evening hours may be said to be in general agreement with the present results.

The authors are indebted to the Council of Scientific and Industrial Research (India) for financial support of these investigations.

Ionosphere Laboratories, E. BHAGIRATHA RAO.
Andhra University, B. RAMACHANDRA RAO.
Waltair (India),
November 20, 1960.

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PAPER CHROMATOGRAPHIC METHODS OF SEPARATION OF COPPER, NICKEL AND COBALT FROM ONE ANOTHER AND THEIR DETECTION

POLLARD and McOMIE,¹ while discussing the chromatography of inorganic ions, drew attention to the solubility of several metallic thiocyanates in organic solvents and suggested that this fact should merit further examination for use in chromatography. In a preliminary paper, Martin² reported that several metallic ions when treated with thiocyanic acid in butanol and eluted on a filter-paper according to Rutter's technique, have R_f values, which differ markedly from ion to ion and this could easily form the basis of separation of these ions from their mixture.

In the separation of metallic ions on paper, several factors are operative, viz., (1) complexation nature of the ion; (2) nature of eluents; (3) pH and (4) treatment of paper. For an effective separation, each of these factors has to be separately considered.

Bock³ made an extensive study of the influence of concentration of the thiocyanate on the distribution of metallic ions between water and organic solvents. Some of the metallic ions, e.g., of molybdenum and tungsten give thiocyanates extractable by organic solvents only in their lower state of valency.⁴ Some other ions become soluble when their mercuric-thiocyanates are obtained.⁵ Precipitates of certain thiocyanates become soluble in organic solvents on addition of pyridine.⁶ A number of possibilities thus present themselves for affecting the separation amongst themselves of ions by taking advantage of the possibilities offered by the above-mentioned complexing procedures which may selectively be employed. The role of eluents in the separation of inorganic ions has been extensively discussed by Lederer and Lederer⁷ in their book and in an exhaustive summary, possibilities of two-dimensional chromatography using groups of solvents has also been discussed.

In the following paper is described the method of separation of some ions using thiocyanates and some selected eluents.

The ions studied were iron, uranium (VI), copper (Ic), nickel and cobalt. The thiocyanates of Fe and U precipitate in an alkaline medium in presence of pyridine, while those of Cu, Ni and cobalt are soluble in the same. Study of the last three ions was made in the first instance.

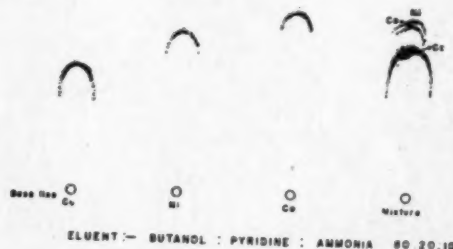


FIG. 1

Solutions

- (1) Copper solution—M/100 and M/500
- (2) Nickel solution—M/100 and M/500
- (3) Cobalt solution M/50

In each case the required quantity of salt, generally the sulphate, was dissolved in water,

and if necessary, a small quantity of the acid was added.

- (4) Potassium thiocyanate—40% in water
- (5) Pyridine (AnalaR)
- (6) Ammonia, CP (0.88)
- (7) Butyl alcohol (CP)
- (8) Amyl alcohol (CP).

One drop each of the solution of the above salts was placed about 2 inches apart on the base line of Whatman filter-paper No. 1. The volume of liquid transferred was about 0.005 ml. from a micro-pipette. When the metal ion spots had dried, about 0.01 ml. of the thiocyanate solution was transferred to each of these, paper-dried, rolled in the form of a cylinder and placed in the trough containing the desired eluent and then covered immediately with a bell-jar. All the usual precautions were taken. The spots were allowed to develop for 2-3 hours. At the end of the period, the paper was taken out, dried and the ions detected suitably. Reasonably compact spots were obtained with the following eluents.

- (1) Butanol : Pyridine : Ammonia (80 : 20 : 10).
- (2) *n*-Amyl alcohol : Pyridine : Ammonia (80 : 20 : 10).

Detection of the ions could best be done as under:

Cobalt.—On exposure to acetone, a blue spot immediately appeared which faded on standing. The position and outline of cobalt was therefore marked with a pencil.

Nickel.—On spraying with 1% alcoholic solution of dimethyl glyoxime, a permanent red spot developed.

Copper.—On spraying with 1% alcoholic solution of rubeanic acid, a slate-grey spot was developed which was also permanent.

The position of the spots in ascending order is copper : cobalt : nickel. The latter two are fairly near to one another and may even overlap.

For the spots to be compact it is necessary to have thiocyanate at least 100 times more than that required to form a complex with the metallic ion.

The technique discussed above may be employed for detecting Cu, Co and Ni when present together in a mixture. After elution with either of the above eluents, the paper is first exposed to acetone. The cobalt, if present, occurs half-way from the liquid front. After marking the spot for cobalt with pencil, the same area is sprayed with dimethylglyoxime. To detect copper, solution of rubeanic acid is sprayed at a distance nearly 2/5 of the distance

to which the liquid front has travelled from the base line. A typical separation obtained from 3γ of Cu, 3γ of Ni and 6γ of Co is reproduced here in the chromatogram. Smallest quantities that can be easily detected are : Cu : 0.6γ, Ni : 0.6γ and Co : 6γ.

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PERSPEX ELECTRETS

ELECTRETS¹ are electrostatic magnets which have many properties similar to magnets but each electret has its own peculiarities. Many substances have been tried for their preparation, but very little work seems to have been done on plastic electrets. Considering the varieties of uses of plastics because of their many important properties, it was thought worth while to attempt the preparation of plastic electrets and study their behaviour. A preliminary report of this work is given in this paper.

Perspex (polymethyl methacrylate) supplied by ICI was tried for this purpose. Electrets were prepared at various temperatures between 120° C. and 160° C. (near the softening point 140° C.) and with different polarising fields (8 to 20 kv./cm.) and their charge decay curves were studied. Here the polarising time was kept constant at 12 hours.

The surface of the electret which was in contact with the positive electrode is referred here as positive surface and the other negative. The surface charge of electrets are referred as homo- and hetero-charges after Gement.² The homo-charge is that which shows the same polarity as the forming electrode while the hetero-charge is that which shows opposite polarity. The homo-charge is attributed³ to the conduction currents across the dielectric-electrode interface, and the hetero-charge is due to the polarisation of ions on the surface of the dielectric.

The results of study may be summarised as follows:—

1. The decay charge curves on the positive surface has the same shape and properties, as observed in the case of carnauba wax electrets.^{1,3,4} The initial charge is hetero for temperatures 150° C., 160° C. and above, while it is only homo-charge for temperatures 140° C., 130° C. and below; irrespective of the polarising voltage.

2. The final charge in all the cases is a homo-charge and it is found to depend on the polarising temperature and also on the field. The maximum charge is 2.1 e.s.u. (temp. 130° C., field 13.33 kv./cm.).

3. At lower temperature, 140° C., the initial charge is found to increase with the increase in polarising field, but at higher temperatures, this is not very regular.

4. Up to the temperature 140° C. the initial charge is only homo- and after this temperature (above 140° C.) we get both the hetero- and homo-charge, with the usual charge reversal from hetero- to homo-charge, after some days.¹

The temperature of this charge reversal is found to depend on the area (total energy) of the so-called "Hysteresis"⁵ curve, drawn between forming field and current.⁶ It is found in the case of perspex that the area of these curves goes on decreasing as the temperature is increased, showing a minimum in area at 140° C. and thereafter the area increases. The existence of the homo-charge and hetero-charge along with their curve characteristics is in agreement with Gross's theory and may be explained on the same basis.³

The charge on the negative surface is not equal and opposite to that on the positive surface.⁴

The author is thankful to Prof. D. R. Bhawalkar and Dr. J. D. Ranade for their interest in the work and to the Ministry of Scientific Research and Cultural Affairs for the award of a Research Fellowship.

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IODOMETRIC AMPEROMETRIC DETERMINATION OF COPPER (II)

COPPER (II) oxidizes iodides with formation of low solubility cuprous iodide: $2\text{Cu}^{2+} + 5\text{I}^- \rightarrow 2\text{CuI} \downarrow + \text{I}_3^-$. The iodine liberated is titrated between pH 3.2 to 5.2 with standard thiosulphate solution titrimetrically using starch indicator, or electrometrically.¹⁻⁵ The electrometric methods are of distinct advantage in the titration of very dilute solutions. Pring and Spencer,³ using the dead stop end-point as described by Foulk and Bawden,² obtained good results with solution as dilute as 0.004 N. In the present investigations, iodometric amperometric estimations of copper (II) at constant voltage with two polarized electrodes have been carried out with success at higher dilutions.

The substances involved in the titration are soluble. The couple, $\text{I}^- \rightarrow \text{I}_3^-$ is reversible and $\text{S}_2\text{O}_3^{2-} \rightarrow \text{S}_4\text{O}_6^{2-}$ is irreversible. The current-potential curves of the system: $\text{I}_3^- + 2\text{S}_2\text{O}_3^{2-} \rightarrow 3\text{I}^- + \text{S}_4\text{O}_6^{2-}$, are shown in Fig. 1.

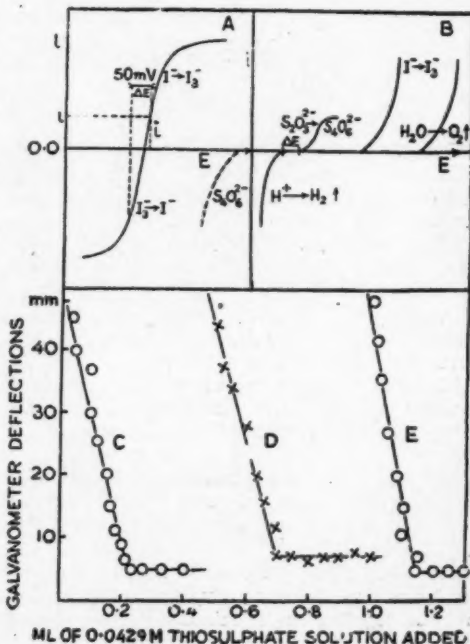


FIG. 1. The current potential curves: (A) before the equivalence point; (B) after the equivalence point; the amperometric titration curves of 20 ml. of (C) 0.00242 M, (D) 0.00148 M, and (E) 0.000493 M copper sulphate in acetate buffer at pH 4.6 against 0.0429 M sodium thiosulphate solution at 0.05 volt with two polarized electrodes.

Anal. pure reagent grade copper sulphate was used to prepare the decimolar stock solution in air-free water, and thiosulphate was Merck's extra pure product. All the other chemicals were C.P. reagent grade products. The stock solutions were standardized potentiometrically, and used after appropriate dilutions with conductance water. The titration vessel was a beaker of 100 ml. capacity, and contains the aliquot, 20 ml. of the titrate in acetate buffer, pH 4-6, with an excess of potassium iodide; it was covered with a tight-fitting rubber stopper provided with holes for the two platinum electrodes, in- and outlet tubes for carbon dioxide, and burette. The titrant was administered from 2 ml. semi-microburette with 0.01 divisions. A constant voltage of the order of 0.05 volt was applied to the electrodes; this value was arrived at empirically. The current through the cell was measured with a mirror galvanometer with a lamp and scale device, and the solution was stirred uniformly during the titration. The equivalence point was determined graphically, and the results are recorded in Table I.

TABLE I
Amperometric iodometric determination of copper (II)

Volume of the titration mixture = 20.0 ml.
Temperature = 25.0° C.

Initial millimolar Concentration of the titrate	Amount of copper (II) in mg.		Experimental value %
	Taken	Found	
4.80	6.111	6.082	99.50
3.57	4.546	4.578	100.71
2.42	3.085	3.109	100.80
1.48	1.883	1.892	100.49
1.02	1.300	1.297	99.77
0.493	0.6270	0.6186	98.70

In the pre-equivalence region, both components of the reversible couple exist in solution and an appreciable current flows through the cell. After the equivalence point there would be no tri-iodide ion left in the solution, and the limiting current corresponding to the cathodic branch of the current-potential curve for the couple $I^- - I_3^-$ is virtually equal to zero. Both components of the couple $S_2O_3^{2-} - S_4O_6^{2-}$ are present in solution, but practically no current flows through the cell, since this couple is irreversible; the applied potential to the cell is 50 mV, and the total resistance of the circuit generally does not exceed a few thousand ohms; the current under these condi-

tions would be of the order of a few micro-ampere if there is no concentration polarization. The corresponding titration curves have the shape shown graphically to exemplify a few experimental results in Fig. 1 (cf. Curves C, D and E). The slope of these curves is the function of concentrations of the titrate.

Results obtained are accurate and precise and 0.63 mg. of copper (II) can be titrated with an error of about 1.5%. The method yields good results in presence of silver, lead, bismuth, stannic tin, aluminium, zinc and nickel. Ferric iron can be rendered harmless by the addition of a sufficient quantity of alkali pyrophosphate. The electrode assembly is very simple and no reference electrode is needed.

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TITRATION COULOMETER

TITRATION Coulometer is generally used for measurement of quantities of electricity less than 10 coulombs.¹ A modified form of this described below may be used to measure larger quantities of current of the order of 80 coulombs or more. Concentrated solution of sodium chloride is used as the electrolyte and the catholyte and the anolyte are separated by a cation exchange membrane previously equilibrated in the sodium chloride solution to be used in the coulometer. The cation exchange membrane prevents the anodic chlorine from contacting the sodium hydroxide formed in the cathode compartment and minimizes, because of reduced pore size and of small concentration differences maintained in the electrolytic cell, the diffusion of ions from one side to the other. Being itself a good conductor, the membrane offers little resistance to the flow of electric current unlike porous diaphragms normally used in this type of work. The electrodes are of bright platinum foil.

The main features of this coulometer are that it (1) does not require costly materials as in the case of silver or Iodine coulometer;

(2) requires but little attention; (3) is suitable for intermittent use and (4) can be used over and over again when once set-up by merely charging the cell with fresh sodium chloride solution.

Materials required are sodium chloride solution of a concentration in the range 1N to saturation and an ion-exchange membrane.

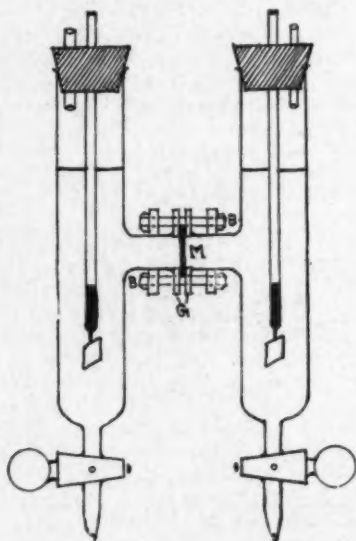


FIG. 1. M = Membrane; B = Brass Bar; G = Rubber Gasket.

An H-type cell (Fig. 1), capacity of each half cell being about 50 ml., bisected by a sodium phenol sulphonate membrane, is used. About 20-30 mA. of current is passed through the cell for about an hour. Larger quantities of current (> 100 coulombs) could be passed by increasing the capacity of the half cells. Otherwise, if larger concentration changes during electrolysis are allowed to build up, ordinary osmotic flow of solvent and diffusion of electrolyte across the membrane are likely to take place and vitiate the results.

After the experiment, the catholyte is drained off and the cathode chamber is washed three times with distilled water. The drained off liquid with the washings is titrated against a standard acid using screened methyl orange as the indicator.

The results obtained with a silver coulometer in series with a membrane coulometer presented in Table I indicate the high order of accuracy obtainable with the titration coulometer.

TABLE I

Concentration of external electrolyte solution (NaCl)	Titration coulometer	Silver coulometer
	Milli-equivalents of NaOH formed	Milli-equivalents of silver deposited
1.0 N	0.7467	0.7461
2.0 N	0.7713	0.7702
3.0 N	0.8692	0.8702
Saturated	0.7630	0.7640

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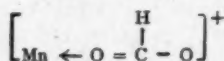
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FORMATION OF Mn (II)-FORMATE COMPLEX

COMPLEX formation of Mn (II) has been studied by electrometric methods employing the aliphatic monocarboxylic acid series like acetic acid¹ and propionic acid² but not with formic acid. We have, therefore, taken up the study of the nature of complex formation between Mn (II) and sodium formate by the conductometric method.

For conductivity measurements (at $25^\circ \pm 0.1$) different sets of solutions were prepared by keeping the concentration of Mn^{2+} constant and varying that of sodium formate. In all cases the total volume was made constant by adding water. When a graph is plotted between the conductance and composition, a clear break at 1:1 is observed. This has been confirmed by the Job's method of continuous variation³ at various compositions, e.g., M/10, M/20, M/30 and M/40 each of $MnCl_2$ and sodium formate. A graph was plotted between the difference in conductance and the ratio $[R]/[R] + [M]$ where [R] stands for the concentration of the ligand used and [M] for the concentration of the metal ion. A maximum in all the cases was found at 0.5 indicating clearly the formation of a 1:1 complex between them.

The structure of the complex assigned is:—



which is supported by the value of the dissociation constant given below.

The value of the dissociation constant has also been determined by the Job's method³ with non-equimolecular solutions using the enlarged equation of Job. In our case since $m = 1$ and

$n = 1$ (being a 1:1 complex) the equation reduces to

$$K = \frac{C [(P + 1)x - 1]^2}{(P - 1)(1 - 2x)}$$

where K = the dissociation constant of the complex, C = the concentration of the metal ion, P = the ratio of the concentration of the ligand and the metal ion solution and x = the maximum amount of the ligand employed.

The average value of the dissociation constant obtained is 1.503×10^{-4} at 25°C .

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BROMINATION OF 2, 4-SUBSTITUTED QUINOLINE DERIVATIVES

RIEDEL *et al.*¹ have prepared 3-bromo-4-quinolinol on bromination of 4-quinolinol in warm glacial acetic acid with bromine. Surrey and Cutler² have reported preparation of 3-halo-2, 4-substituted quinolines by means of sulphuryl chloride, bromine or iodine monochloride in glacial acetic acid. Meyer *et al.*,³ by brominating 2, 4-substituted quinoline, also obtained its 3-bromo derivative. Chick and Wilsmore,⁴ by direct bromination prepared 3-bromo-2-hydroxy-4-methylquinoline, which was shown to be identical with the product obtained by cyclisation of monobromo acetoacetanilide with concentrated sulphuric acid.

A number of 3-bromoquinoline derivatives (III), using bromine in acetic acid in presence of a trace of iodine as catalyst, has been prepared from 2, 4-substituted quinolines (I). These 3-bromoquinolines (III) have also been obtained by cyclisation of monobromo acetoacetarilamides and of monobromo malonmonoarilamides (II).

2-Hydroxy-4-methylquinolines have been prepared by the method of Ewins and King,⁵ while 2, 4-dihydroxyquinolines by that of Mehta and Patel.⁶ These 3-bromo quinoline derivatives are crystallized from alcohol in white needles.

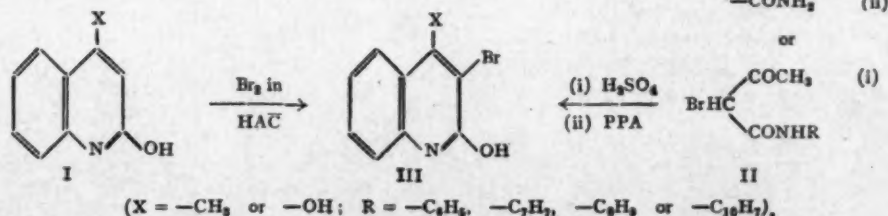
Acetoacetarilamides,^{5,7} on bromination, gave corresponding monobromo derivatives, which, on cyclisation with concentrated sulphuric acid, yielded 3-bromo-2-hydroxy-4-methylquinolines; whereas the respective monobromo derivatives from malonmonoarilamides,^{8,9} on cyclisation with polyphosphoric acid at 140°C ., gave 3-bromo-2, 4-dihydroxyquinolines. These 3-bromoquinolines, obtained both by direct and indirect methods, are found to be identical by determination of their melting points and mixed melting points.

One of the authors (G. H. P.) is thankful to M.S. University of Baroda for a Research Assistantship to carry out this work.

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DEFICIENCY OF GLUCOSE-6-PHOSPHATE DEHYDROGENASE—OBSERVATIONS ON A SAMPLE FROM BOMBAY

It has been observed that certain drugs like primaquine, sulphanilamide, etc., induce an acute hæmolytic anaemia in some patients.^{1,2} Favism also exhibits similar symptoms.³ The concentration of reduced glutathione was found to be lower in primaquine-sensitive individuals than in others.⁴ This reduction in the average GSH concentration has been traced to a deficiency in the enzyme, glucose-6-phosphate dehydrogenase, in the erythrocytes of sensitive individuals.⁵

This enzyme deficiency has been observed in American Negroes,⁶ Sephardic Jews,⁷ Italians,⁸ Greeks⁹ and some African populations. It is rare or almost absent in Northern European and American Whites¹⁰ and Ashkenasic Jews.⁷

A relatively high incidence of primaquine-induced hæmolytic anaemia reported earlier in Indians¹¹ suggested that the deficiency of glucose-6-phosphate dehydrogenase might be present among them. The present study comprising of an unselected sample of 110 individuals from Bombay City confirm this suggestion.

TECHNIQUE

In order to make the method suitable for fieldwork, it was standardized using finger prick blood. The blood sample was collected in 3.8% citrate solution. The criterion for the test was the disappearance of the dye⁶ brilliant cresyl blue, as suggested by Dickens and Glock¹² and Motulsky and Campbell.¹³

The method is based on the fact that TPN⁺ in the reaction is reduced to TPNH. The H⁺ is then passed over to the dye which becomes colourless when reduced.

The reaction mixture consisted of:—

(ml.)	
0.04	washed erythrocytes
0.50	distilled water
0.50	0.2 M Tris buffer, pH 7.5
0.10	0.3 M MgCl ₂
0.10	0.02 M Sodium G-6-P
0.25	TPN (100 µg.)
0.20	Brilliant cresyl blue (1×10 ⁻³ M)

The mixture was covered with 1 ml. of liquid paraffin to avoid contact with air and was kept at 37° C.

Most of the samples started decolorisation between 2 hours 45 minutes and 4 hours after the start of reaction. The samples which did not start decolorization up-till 4 hours and 30

minutes were taken as deficient; the earliest one showing a time of 4 hours and 40 minutes.

TABLE I

Time (in hours) taken for the start of decolorisation

Time	No. of persons	
	Male	Female
≤1.25	1	..
2.25-2.50
2.50-2.75	9	2
2.75-3.00	12	8
3.00-3.25	12	5
3.25-3.50	17	3
3.50-3.75	9	..
3.75-4.00	14	2
4.00-4.25	1	..
4.25-4.50
4.50-4.75	3	1
4.75-5.00	3	2
>5.00	..	6
	81	29

All the samples were tested on the day of collection.

RESULTS

110 individuals, consisting of 81 males and 29 females between ages 20 and 40 were tested. 6 males and 9 females were found to be deficient for the enzyme (see Table I). This enzyme deficiency is considered to be controlled by a sex-linked, incomplete dominant gene.¹⁴ The female heterozygotes may give test results ranging all the way from normal to abnormal.

The distribution of normal and deficient individuals by community is given in Table II.

TABLE II

Community distribution of the individuals tested

		Males		Females	
		Total	Def.	Total	Def.
1	Maharashtra—Hindus	35	..	8	2
2	Konkan—Hindus—Saraswats	10	2	5	1
3	Parsis	3	..	9	5
4	Christians	12	..	1	..
5	Others	21	4	6	1
		81	6	29	9

The enzyme deficiency appears to be widely distributed in the country as the deficient individuals originated from Maharashtra, Gujarat, Mysore and Kerala. As many as 5 out of 9 Parsi females tested were deficient, some of them taking more than 6 hours for the start of decolorization. Saraswats of Konkan showed

3 deficient individuals out of 15 tested. Further investigations in some of these communities are in progress.

We are greatly indebted to Dr. V. R. Khanolkar for the sustained and deep interest he has shown in this investigation. We wish also to acknowledge our gratitude to all those who willingly co-operated with us by giving us blood.

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A MODIFIED METHOD FOR THE DETERMINATION OF AMMONIA AND NITRATE IN CEYLON TEA SOILS

INTRODUCTION

DURING the course of our work on the mineralisation of the organic nitrogen in Ceylon Tea soils, considerable difficulties were encountered in obtaining comparable results when different methods (as reported in the literature) were used for the determination of ammonia and nitrate. It has generally been the practice of each agricultural laboratory to use only one particular set of methods for the routine analysis

of these plant nutrients. In an attempt to standardise a method for routine work in this laboratory, several methods reported in the literature were tried.

Several widely different methods of extraction of mineral nitrogen have been used by different workers. For example, Piper (1950) has reported the use of the classical method of extraction using a mechanical shaker for one hour with 2N potassium chloride solution at pH 1.0 to 1.5. Cornfield (1952), on the other hand, treated the soil with animal charcoal plus 0.5N sodium acetate solution for one minute before determining the nutrients in the extract colorimetrically. Rodrigues (1954) treated the soil repeatedly over a filter-paper with N potassium chloride solution at pH 1.0 for the determination of ammonia. In a publication of the Association of Official Agricultural Chemists (1945), a method is described in which precipitated calcium carbonate is used for the clarification of the soil extracts in the colorimetric determination of nitrate.

Freshly sampled up-country Ceylon tea soils rarely contain more than 5 p.p.m. nitrate; various colorimetric methods were tried in order to measure these minute quantities of nitrate, but they gave highly variable results and sometimes the colour could not be matched against the standard. The method of reduction of the nitrate to ammonia (Piper, 1950) and its subsequent determination is probably more accurate but considerable difficulties were encountered in adopting this method also. Using even the most efficient spray catchers during the distillation, the blanks were found to give high and variable results due to the alkali-spray passing over into the distillate. Attempts were made to choke the spray fluid with glass beads, glass wool, etc., but with no improvement. It was therefore thought that a double distillation carried out as one process, would obviate these difficulties. This paper gives a brief description of the methods used and the results obtained.

METHODS

A micro-distillation apparatus (Kjeldahl) was used, but in place of the steam generator there was a 500 ml. flask containing the test solution, connected to the main distillation apparatus through a simple spray catcher. A small quantity of magnesium oxide was introduced into the second distillation tube which was heated by a micro-burner. An aliquot of the soil extract containing at least 0.2 mg. nitrate nitrogen was treated with magnesium oxide plus Devarda's alloy and distilled very slowly

(30-45 mins.) into standard acid. Any alkali-spray passing over the first distillation flask was held up in the second distillation tube.

EXPERIMENTAL RESULTS

1. *Recovery of ammonia and nitrate nitrogen from an artificial mixture of nutrients.*—The results of experiments on recovery from a mixture of standard ammonium chloride and potassium nitrate solution are shown in Tables I and II. It is evident from the results shown in Table II, that a slow rate of distillation is imperative for the quantitative recovery of the nitrate nitrogen.

TABLE I

Recovery of ammonia from a mixture of ammonium chloride and potassium nitrate

Experiment No.	Mineral nitrogen present in the mixture		Ammonia nitrogen recovered (μg.)	% recovery
	Ammonia nitrogen (μg.)	Nitrate nitrogen (μg.)		
1	1000	1000	983	98.6
2	1000	2000	998	99.8
3	1000	3000	988	98.8
4	2000	1000	2076	101.8
5	3000	1000	2987	99.6

TABLE II

Recovery of nitrate from a mixture of ammonium chloride and potassium nitrate

Experiment No.	Period of distillation (minutes)	Mineral nitrogen present in the mixture		Nitrate nitrogen recovered (μg.)	% recovery
		Ammonia nitrogen (μg.)	Nitrate nitrogen (μg.)		
1	20 (Normal)	1000	1000	915	91.5
2	10 (Fast)	1000	2000	1158	57.9
3	20 (Normal)	1000	3000	2374	79.1
4	30 (Slow)	..	2000	2001	100.0
5	30 (Slow)	..	2000	1982	99.1

2. *Recovery of added ammonia and nitrate from tea soil.*—200 g. of St. Coombs cultivated top soil (0-6") was mixed thoroughly with known quantities of ammonium chloride plus potassium nitrate and extracted with 400 ml. of 2 N. potassium chloride solution (adjusted to pH 1.0 with hydrochloric acid) in a mechanical shaker for one hour. The extract was filtered through No. 42 Whatman filter-paper and a suitable aliquot of the filtrate was used for the determination of ammonia and nitrate by the above method. Relevant blanks were run and the necessary corrections made for the moisture present in the soil.

Typical results of recovery experiments are shown in Tables III and IV.

TABLE III

Recovery of added ammonia from the tea soil

Experiment No.	Mineral nitrogen added to the soil		Total ammonia nitrogen present in the soil (calculated) (μg.)	Ammonia nitrogen recovered (μg.)	% recovery
	Ammonia nitrogen (μg.)	Nitrate nitrogen (μg.)			
1	None	None	..	1426	..
2	500	500	1926	1920	99.7
3	500	1000	1926	1900	98.7
4	1000	500	2426	2426	100.4

TABLE IV

Recovery of added nitrate from the tea soil

Experiment No.	Mineral nitrogen added to the soil		Total nitrate nitrogen present in the soil (calculated) (μg.)	Nitrate nitrogen recovered (μg.)	% recovery
	Ammonia nitrogen (μg.)	Nitrate nitrogen (μg.)			
1	None	None	..	2191	..
2	500	500	2691	2637	98.0
3	500	1000	3191	3171	99.4
4	1000	500	2691	2695	100.1

SUMMARY

An improved rapid method for the simultaneous determination of ammonia and nitrate present in Ceylon tea soils is described. The classical method of single distillation was found to be unsatisfactory even when using very efficient and modified spray-catchers. On the other hand, a double distillation method using a micro-distillation apparatus was found to be both rapid and efficient for the quantitative recovery of ammonia and nitrate from the tea soil extracts.

Tea Research Institute, M. S. RAMASWAMY.
St. Coombs,
Talawakelle, Ceylon,
October 3, 1960.

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OCCURRENCE OF KYANITE-QUARTZITE FROM VARUNA SCHIST BELT, MYSORE

A SMALL belt of hornblende schist, occurs 3 miles to the east of Chamundi Hill, near the village Varuna, Mysore District, which is considered to be the extension of the Nagamangala schist belt, occurring as discontinuous stringers and patches.¹ The schist belt runs over 7 miles northwards, from Varuna village with a width of 2-4 furlongs. The belt forms a small ridge whose trend is also N-S. The rock is composed of big prismatic crystals of hornblende ranging in size from 1"-1½" in length, and garnet. The belt is bordered on either side by hornblende gneiss. Amidst this schist belt are found small narrow intercalated bands of kyanite-quartzite, which is very localised in its occurrence. Its strike is N 20° W to S 20° E, and dips at an angle of 70° towards north-east.

The schist belt comprises of rocks which are essentially amphibolites, hornblende schists and quartzites. The amphiboles of amphibolites have a tinge of brown colour along the 'Y' direction. This amphibole resembles the amphiboles generally reported from charnockites.² The rocks are typically granulitic in texture. Their mineral composition may vary from plagioclase-diopside-granulite, to amphibole-hypersthene granulite to pure amphibole granulite.

The plagioclase-amphibole granulites have plagioclases of 35% anorthite, and the amphiboles have the following optical characters:

(-) 2V = 79°; ZAC = 17°; (γ - α) = 0.020;
X = brownish-yellow, Y = yellowish-green,
Z = dark-green.

The amphibole sometimes shows a sieved structure, indicating thereby that the amphibole has developed at the expense of pyroxene. Quartz is always rounded and occurs both in amphibole and in the rest of the slide. The diopside is cloudy, traversed by cracks and dotted with iron-ore, whereas the amphibole is clear. The amphibole in such cases where there are relics of diopside are intensely pleochroic.

There are amphibolites in the schist belt in which the diopside and hypersthene have disappeared and the resulting rock is composed entirely of strongly pleochroic amphibole and quartz. In these amphibolites the sieve structure is more evident. The amphiboles may pass on to granules of garnet. In hand specimen, these amphiboles have needle-like habit and may be called appinites. Sometimes there are occasional pockets of bronzite³ included among the schists.

The kyanite-quartzite exhibits a mosaic texture composed of quartz, kyanite, sillimanite and mica. The optical characters of sillimanite are: (+) 2V = 29°; (γ - α) = 0.027. The accessories are sphene, rutile and pyrite. The quartz gives faint undulose extinction. Some of the quartzes show regular banding. Occasionally the kyanite is converted into sericite mica (refer Fig. 1).

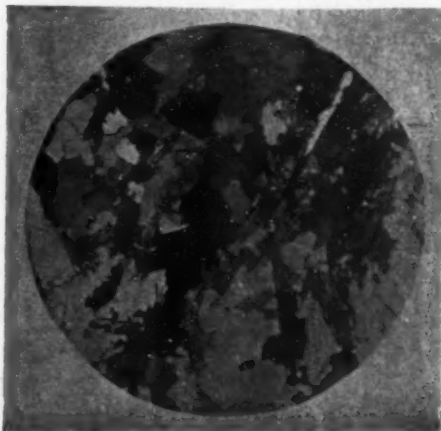


FIG. 1

There are also bands of intercalated fuchsite quartzites with accessory rutile and sphene. The rutile or sphene sometimes alter to a brown patch, possibly limonite (?). There are relics of kyanite within these fuchsite bands. The optical properties of fuchsite are: γ = β = 1.597; (γ - α) = 0.038; (-) 2V = 30°; XZ plane perpendicular to (010).

Kyanite from kyanite-quartzite was separated by heavy liquids and chemically analysed. Its chemical composition is: SiO₂ = 37.60, Al₂O₃ = 61.83, Fe₂O₃ = 0.35, H₂O = 0.32, total = 100.10. The empirical formula computed from the chemical composition conforms with the formula for kyanite given by Dana.⁴

The optical characters of the kyanite are: (-) 2V = 84°; (γ - α) = 0.012; (β - α) = 0.007; ZAC = 24°; Sp. Gr. = 3.589.

The occurrence of kyanite-quartzite with the hornblende-hypersthene granulites of Varuna schist belt has for the first time been reported by the present author. The association points to the high grade metamorphism of the schists in the Varuna area, which is in accordance with the general increase in the metamorphic grade of the rocks of Mysore State, where, metamorphism increases from north to south. Actually the

Varuna schist belt is situated at the south-western extremity of the Mysore State.

Dept. of Applied Geology,
University of Saugar,
Saugor, September 24, 1960.

S. K. BABU.

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EMPLACEMENT OF PEGMATITES IN KONDAPALLE AREA

DURING the course of detailed geological mapping of the Kondapalle hills, the author came across a large number of pegmatite exposures. As many as 75 exposures were studied on the lines suggested by Goodspeed¹ and Chandwick,² in order to know the exact mode(s) of their emplacement. Only a small number of these pegmatites exhibit features which can be used as criteria for distinguishing their modes of emplacement.



FIG. 1

The pegmatites are relatively coarse-grained and are granitic in character containing quartz and alkali feldspar (perthitic) as essentials. They generally occur as straight tabular bodies and rarely as lens-shaped ones in the charnockites or granite-gneisses. The colour of the pegmatites is either grey or pink and their width varies from a few inches to fifty inches, and the length from a few feet to many tens of feet. Their general trend is between NNW and NNE directions.

The pegmatites in general have an apparently sharp contact with the charnockites and a gradational one with the granite-gneisses. There is

a singular structural evidence of displacement of a wall rock unit (basic charnockitic band), proportional to the width of pegmatite and angle of intersection. This is the most useful criterion for identifying a dilational pegmatite. Where the pegmatites occur in granite-gneisses, the latter are much disturbed and folded; the foliation of wall rock gneisses has become parallel to the contacts of the pegmatite and is bent in the same direction on both walls of the pegmatite (Fig. 1). These features are supposed to have resulted when the pegmatite during intrusion dragged the adjacent rocks toward parallelism with its borders, but not due to post-emplacement deformation. This is further corroborated by the absence of signs of shearing along the pegmatite margins and of indications of deformation in the pegmatite minerals. Hence it is supposed that forceful emplacement is a significant mechanism by which these pegmatites were emplaced.

Some of the pegmatites which are lens-like were probably developed during permissive emplacement, as no evidences of forceful emplacement are met with. Since there is no

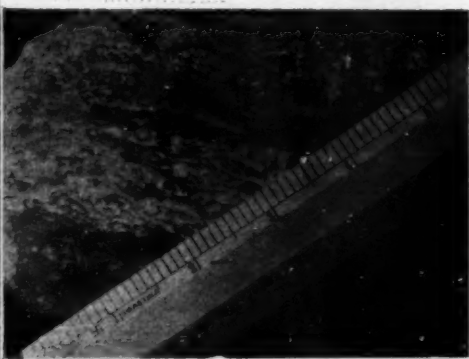


FIG. 2

special relationship between pegmatite and adjacent wall rock compositions, it is not possible to distinguish displacement from non-displacement.

Introduction was a dominant mobile process during the course of emplacement of those pegmatites whose adjacent walls are enriched in pegmatitic constituents and those which are having narrow offshoots into the gneisses parallel to the gneissosity. It is significant in this connection to note the occurrence of monazite in the granite-gneisses adjacent to the pegmatite, as reported by the author³ earlier.

In contrast to the above, a few pegmatites exhibit features which are considered to be non-dilatational or non-mobile. These features include gradational or diffuse borders, the elongation of the pegmatite minerals in the same direction as the adjacent gneiss and lastly the occurrence of thin stringers of host rock as relics, being arranged parallel to the pegmatitic borders (Fig. 2). The metamorphic-metasomatic theory of Ramberg⁴ can explain to a very large extent these phenomena in a satisfactory manner. In a few cases, interesting evidences for the pegmatite emplacement are noticed indicating the process to be one of a combination of different mechanisms.

The author desires to express his grateful thanks to Dr. S. Balakrishna, for many helpful discussions throughout the work.

Geology Department, CH. LEELANANDAM.
Osmania University,
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November 3, 1960.

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PREMNA RESINOSA SCHAU.
(VERBENACEAE) AN ADDITION TO
INDIAN FLORA

HOOKE¹ described 25 species of the genus *Premna* from India. Six more species have been added bringing the total species of this genus in India to 31. Of these, 18 species occur only in the eastern and western Himalayas and the adjoining submontane regions; 13 species occur in the central and southern India.

Cooke² and Talbot³ described only two species *P. coriacea* Cl. and *P. integrifolia* Linn. from Bombay State. While examining the materials of the Verbenaceae from Kutch some specimens could not be fixed in any of the *Premna* species reported from India. These specimens which had been collected from several localities in Kutch belong to one of the commonest shrubs of the area. It is a large bushy shrub about 2 m. high, with small panicles and black drupes of the size of pea. Indrajai Thakar⁵ has described another doubtful species from Kutch *P. herbacea*?. The description given by Indrajai Thakar under the name *P. herbacea*? resembles this material but the name *P. herbacea* for it is obviously wrong as *P. herbacea* Roxb. is a small undershrub only few cm. high, with an inconspicuous stem and large leaves (Hooker, loc. cit.).

Santapau probably collected this very plant from Saurashtra. He followed Indrajai Thakar's conception as he doubtfully mentions *P. herbacea* Indrajai in his list.⁶ The Kutch plants agreed with the description of *Premna resinosa* (Hochst.) Schau. This specimen was referred to the Keeper of the Central National Herbarium, Calcutta; who confirmed the identification. This species is not reported so far from India. It occurs in Tropical Africa and Arabia.



FIGS. 1-3. *Premna resinosa* Schau.

Fig. 1. A part of plant. Fig. 2. A flower. Fig. 3. A fruit.

P. resinosa (Hachst.) Schauer in *Dc. Prodr.*, 11, 637; Dyer, *Fl. Trop. Afr.*, 1900, 3, 289; Blatter, *Fl. Arabia, Rec. bot. Surv. India*, 1921, 8 (3), 365; Andrew, *Fig. Pl. Sudan*, 1956, 3, 198.

An erect shrub, about 2 m. high, stem much branched above, branchlets slender, angular, white, glabrous or slightly pubescent; leaves opposite petiolate, entire or distantly crenate, ovate or elliptic oblong, obtuse at apex, 0.8-3 cm. long. Inflorescence of small terminal pedunculate corymbose panicles; flowers very small; calyx small cup-shaped, about 3 mm. long, limb minutely 5-toothed, teeth almost obsolete in fruit; corolla greenish-white, 5 mm. long, 4-lobed, 2-lipped; stamens 4, didynamous, alternating with corolla lobes, not exserted; ovary 4-ovuled; drupe size of a small pea, black, globose.

Dhinodhar-Jain 46917 (20-10-1958); Khavada-Kala Dungan-Jain 61820 (6-4-1960) and 61867 (7-4-1960).

Very common in Kutch in hilly areas on rocky substratum.

The material referred by Indrajai Thakar as *P. herbacea*? and Santapau as *P. herbacea* Indrajai belongs to this species.

The plant is locally known as 'Kunder' or 'Ghiteli'.

I am grateful to Dr. J. C. Sen Gupta, Dr. S. K. Mukharjee, Shri R. S. Rao and Shri S. K. Jain for their kind advice and help in the preparation of this note.

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Botanical Survey of India,
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EFFECT OF INFECTION OF SPHAC- LOTHECA SCHWEINFURTHIANA, THUMEN. ON SPIKELET STRUCTURE IN ERIANTHUS MUNJA

THE occurrence of abnormal and proliferating spikelets consequent on gene action, unfavourable environment and infection by diseases has been commonly noticed. Fungi belonging to the Ustilaginales causing infection of floral organs have been known to induce abnormalities in grasses. In sugarcane, Sharma² has recorded abnormalities in floral structure of sugarcane consequent on the attack of *Ustilago scitaminea* sp. affecting the genus *Saccharum* or *Ustilago* sp. affecting the genus *Erianthus*.

Among the collections of *Erianthus* species at this Institute, a few forms of *E. munja* have been noticed to be infected by *Sphacelotheca schweinfurthiana*, Khanna and Ramanathan.³ No other species of *Erianthus* is infested. The arrows when fully emerged from the leaf-sheath present a blackish appearance due to the occurrence of sori inside the glumes. All arrows are infested and practically each and every spikelet.

Examination of the spikelets revealed the occurrence of certain abnormalities which are reported here. In the young arrows where only the glumes, palea and lodicules are developed, these floral parts are normal. At a later stage when the essential organs get differentiated, instead of the stamens and pistil a black mass appears at the centre of the individual spikelets transforming the ovary into a smut sorus. This

is developed by a thin, hyaline pseudomembrane. At a later stage abnormalities are noticed in the form of extra glumes, giant-sized lodicules, staminodes, etc. The usual sterile glumes are not affected excepting for a little increase in size. Out of the 50 random spikelets examined, additional glumes were noticed in all excepting four. These vary from one to six per spikelet, the majority recording one or two. When only one extra glume is present, it is a duplication of the third glume. When more than one both the third and fourth glumes (fertile lemmas) are involved. The palea in all cases is normal. The lodicules are often bigger in size with prominent terminal cilia. Often one or both of them are absent.

In the case of the essential organs, the male organs are suppressed and only staminodes are noticed with a short filament and two-lobed, empty anther sacs. In most cases only two staminodes are noticed. The columella characteristic of the genus and consisting of modified ovarian tissue and fungal elements is prominently visible. Normally only one sorus is seen in each spikelet. In a few cases, two sori, independent of each other with two additional glumes subtending each of them are seen.

Thanks are due to Dr. J. T. Rao, Botanist, for help and guidance and to Dr. N. R. Bhat, Director, for interest and encouragement.

U. VIJAYALAKSHMI,
S. MARIMUTHAMMAL.

Sugarcane Breeding Institute,
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CALOBRYUM NEES—A GENUS NEW TO INDIAN FLORA*

THE genus *Calobryum* is a remarkable member of the Hepaticae because of its characteristic erect, radially symmetrical gametophytes with three ranked more or less similar leaves—features shared by the only allied genus *Haplomitrium*. Apart from these distinctive vegetative features of *Calobryum* the apical disposition of antheridia and archegonia are as in the mosses. The genera *Calobryum* and *Haplomitrium* have been associated with affinities

* Contribution from the Department of Botany, Lucknow University, India, New Series (Bryophyta), No. 48.

of immense phylogenetic significance (Campbell,¹ Smith,² Fulford³ and Campbell⁴) and are regarded as the most primitive of the liverworts.

Calobryum, with its four (Campbell⁴) or five (Campbell¹) known species, has a very restricted distribution and is primarily confined to the southern hemisphere with an extended northern range in Japan. The present report of this interesting plant from India thus not only extends the range of distribution of this rare liverwort but also constitutes a significant addition of such an important genus to our Hepatic flora. The plant was collected by one of us (Udar) from Ghoom (alt. ca. 6,500 ft.) in Darjeeling on January 2, 1959.

The specimens collected are fertile. However, mature sporophytes are not represented although several young stages are present. The main taxonomic features of the Darjeeling specimens are described below:

The plants are up to 1.5 cm. in length. The erect gametophores are gregarious and arise from a tangled mass of rhizomes which are interwoven with several leafy liverworts. The rhizomes grow to some length and then curve upwards (Figs. 1, 3, rh) forming the leafy

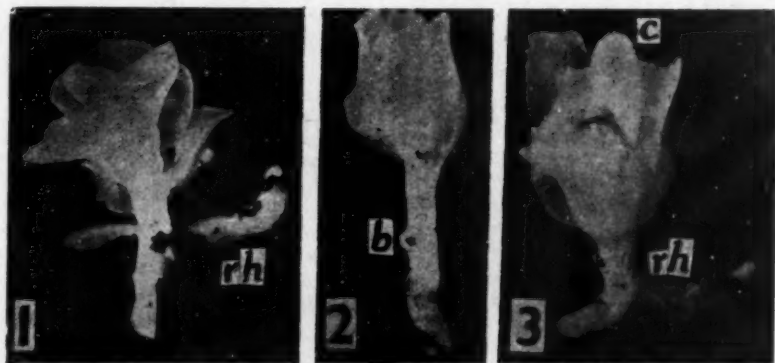
The female plants (Figs. 2, 3) have the three rows of leaves compactly arranged particularly towards the apex. They surround the developing archegonia effectively and expand out in later stages. About 25 mature archegonia were counted. These have the characteristic long necks which towards the terminal portion have twisted rows of cells.

The young sporophyte is surrounded by a massive "calyptra" (Fig. 3, c) which is cylindrical and is up to 8 mm. long. It carries several fertilised or shrivelled archegonia at its base and often also towards the apex.

Though in its external morphology the specimens from Darjeeling approach *Calobryum gibbsiae* St.—a species known from New Zealand (Campbell⁴)—yet in the size of the leaves and its cells as well as developmental details of antheridia, archegonia and the embryo there are significant differences. A fuller discussion embodying these details will shortly be published elsewhere.

Department of Botany,
Lucknow University,
Lucknow, June 7, 1960.

RAM UDAR.
SATISH CHANDRA.



FIGS. 1-3. Fig. 1. A male plant. rh, rhizome. Fig. 2. A young female plant. Note the close aggregation of the leaves at the apex. b, point at which rhizome has broken. Fig. 3. A female plant with a young sporophyte. c, conspicuous cylindrical "Calyptra"; rh, rhizome. (All figures, $\times 10$.)

gametophores. The entire plant completely lacks rhizoids but numerous multicellular mucilage hairs occur on them.

The male plant (Fig. 1) has the leaves loosely disposed which are normally all alike. The compact growth of the thalli, however, results in comparatively smaller leaves at the base and larger towards the apex. There are well over 100 antheridia in different stages of the development at the apex of the male shoot.

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OCCURRENCE OF ACRASIALES IN INDIAN SOILS

In a recent letter on soil micro-fungi of Uttar Pradesh, Rai and Tewari¹ say that "nothing was known till now about the members of Acrasiales inhabiting soils of this country" and that *Dictyostelium mucoroides* Bref. and *Polysphondylium violaceum* Bref. are being reported by them for the first time.

The above statements are not correct. I should like to draw their attention to my paper² published in 1956, in which I have recorded 6-7 species of Dictyosteliaceae from several soil samples and rhizosphere of diverse species of plants in South India.

The species reported by me are *Dictyostelium mucoroides* Bref., *D. discoideum* Raper, *D. minutum* Raper, *D. purpureum* Olive, *Polysphondylium pallidum* Olive, *P. violaceum* Olive and possibly *Dictyostelium giganteum* Singh.

V. AGNIHOTHRUDU.

Tocklai Experimental Station,
Indian Tea Association,
Cinnamara, Assam, December 12, 1960.

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EFFECT OF INDOLE ACETIC ACID ON THE NITROGEN AND CARBOHYDRATE METABOLISM OF EXCISED WHEAT LEAVES

It was shown by Christiansen and Thimann¹ that during the growth of sections of etiolated pea-stems in indole acetic acid solution a considerable amount of sucrose and reducing sugar was consumed; also the respiration of the tissue was stimulated by 15 to 25% over that of sections grown in water alone. Similar studies conducted with leaf will be especially useful to gather information of a fundamental nature regarding some of the important metabolic processes occurring in plant. In this study such an attempt was made with excised wheat leaves in order to gain some information regarding the nitrogen and carbohydrate changes as influenced by indole acetic acid.

Samples of wheat leaves (var. "Little Joss") weighing 2.0 gm. obtained from 7-day-old seedlings of uniform growth were taken for initial analysis of (1) soluble-N, (2) soluble nitrogen including nitrate, (3) insoluble-N, (4) reducing sugar, (5) total sugar and (6) acid hydrolysable polysaccharide. Similar leaf samples were transferred at known time to Petri dishes which contained (1) 20 ml. of 1% glucose solution

containing N/10 KNO₃ and (2) 20 ml. of 1% glucose solution containing N/10 KNO₃ and 5 p.p.m. indole acetic acid. These were incubated in dark at 27°C. The Petri dishes and the nutrient medium had been previously sterilized. After an interval of 24 hours the leaves were analysed for the different nitrogen and carbohydrate fractions.

The leaves were extracted for total soluble-N as described by Austin.² Total soluble-N and insoluble-N were determined according to the microdiffusion method of Conway.³ Total soluble-N including nitrate was determined by the reduced iron method of Pucher, Leavenworth and Vickery.⁴ Reducing sugar, total sugar and acid hydrolysable polysaccharide were determined according to the Hagedorn-Jenson method.

TABLE I

Changes in the carbohydrate and nitrogen fractions of the leaf

(Mean values of 2 readings are given; values expressed as mgm./1 gm. fresh weight)

Constituent	Treatments					
	Initial	24 hours in sugar-nitrate medium	% increase or decrease from the initial	24 hours in sugar-nitrate medium + 5 p.p.m. I.A.A.	% increase or decrease from the initial	
Polysaccharide ..	20.96	21.78	+ 4.1	19.06	- 9.0	
Total sugar ..	20.68	20.55	- 0.48	19.58	- 5.3	
Reducing sugar ..	19.83	19.74	- 0.45	18.85	- 4.9	
Soluble-N ..	0.712	0.918	+28.9	0.975	+36.9	
Soluble-N including nitrate ..	0.710	0.978	+36.0	1.007	+40.1	
Insoluble-N ..	2.034	2.424	+19.2	2.461	+21.06	

It can be seen from Table I that soluble-N, total soluble-N including nitrate and insoluble-N of the leaf kept in both the solutions increased considerably at the end of the 24-hour experimental period. The leaves floated in sugar-nitrate solution containing indole acetic acid had more total soluble-N and total soluble-N including nitrate than the leaves floated in sugar-nitrate solution alone. As regards insoluble-N the values were more or less the same irrespective of nutrient solutions.

As regards carbohydrates, there was a slight increase of acid hydrolysable polysaccharide in the leaves supplied with the sugar-nitrate medium, whereas reducing and total sugars remained more or less constant. When indole acetic acid was also present in the medium, all these three carbohydrate fractions decreased,

this decrease being more marked with the acid hydrolysable polysaccharide. These changes can be explained in the light of the reactions shown in Fig. 1.

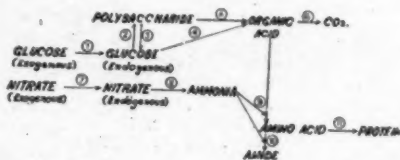


FIG. 1

If reaction 2 is faster than reactions 3, 4, 5 and 6, there will be an increase of polysaccharide, whereas if the reverse is the trend, then a decrease of this fraction will occur. The observed loss of polysaccharide in auxin-supplied leaves suggests that the latter alternative is the trend of metabolic reactions brought about in the leaves by the action of indole acetic acid. This observation is interesting in the light of the finding made by several workers that the application of auxin stimulates the respiration of a tissue. More carbon skeletons will be used as a result of an enhanced rate of respiration, and this, in the present case, will have to be obtained from an oxidative breakdown of reserve carbohydrates (possibly from polysaccharide). When nitrate is also present in the system, reactions 8, 9, 10 and 11 also will occur simultaneously. Thus the observed decrease of polysaccharide must have been possibly due to respiratory destruction as well as to conversion to other non-carbohydrate type of cell constituents. The results presented in Table I furthermore show that with regard to the nitrogen fractions, the effect of indole acetic acid was manifested in the production of more soluble-N (and soluble-N including nitrate) which would indicate that although total soluble-N increased, insoluble-N was not formed. This may indicate that the ready formation of insoluble-N might have been considerably prevented due to a possible non-availability of particular amino-acids necessary for protein synthesis.

I am thankful to Professor W. H. Pearsall, Professor of Botany, University College, London, for providing me facilities to conduct this work at the Botany Department of the University College. I am also thankful to Mr. P. J. Syrett for his suggestions.

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STUDIES ON THE RHIZOSPHERE MICROFLORA OF CITRUS PLANTS AS INFLUENCED BY STREPTOMYCIN SPRAY

It is well established that the rhizosphere region of plants is the site of increased microbial activity as compared to the soil. Depending upon the plant species, its age, etc., the increase in population may range from a few to a hundred times or even more. The rhizosphere of several annual angiosperms and a few pteridophytes have been studied by several workers but not much work seems to have been done on the perennial plants, except for the report of Obratzova¹ stating that a two-year-old tea bush harboured more number of microorganisms than the old flowering tea bushes and also that of Gyllenberg and Hanioja² reporting that grasses harboured greater number of microorganisms than the trees.

With a view to examine the rhizosphere microflora of acid lime [*Citrus aurantifolia* (Christm.) Swingle] plants, a widely grown perennial orchard tree, studies were undertaken in the Annamalai University Experimental Orchard, Annamalaiagar, and the results are reported here. In the recent studies^{3,4} made in the same orchard on the control of the canker disease of acid lime plants caused by *Xanthomonas citri* (Hesse) Dowson, it was observed that streptomycin sprays not only checked the disease but also caused better growth of the plants with fresh dark green shoots as against chlorotic stunted appearance of the unsprayed plants. In order to examine the possible effect of streptomycin in causing any physiological change of the plant, as could be indicated by the rhizosphere population, studies were made and these results also are reported here.

A total of 36 plants, about four years old and in the second year of bearing, were selected in a block in the orchard for these studies. Six plants, selected at random, were sprayed with 1,000 p.p.m., of aqueous streptomycin sulphate (E. R. Squibb & Son, containing 729 units/mg.), together with 1% glycerine, added for better penetration by the spray. The

presence of streptomycin in the leaf, stem and root tissues was examined by the same technique used in the earlier studies. Indications were obtained for the presence of streptomycin in the leaf and stem, starting from 24 hours after spray up to 15 days, but at no time was there any indication for the presence of traceable amount of streptomycin in the root tissues.

To examine the rhizosphere microflora, root samples were collected from the sprayed and unsprayed plants. The soil was dug out carefully and the lateral roots exposed. The tips of young growing roots were selected, avoiding the older ones that have become thick and woody. About an inch long tips were clipped off from the root, the excess soil particles adhering to them removed by gentle tapping and the root bits transferred to 100 ml. portions of sterile tap-water in flasks. From each plant root bits were selected at random from three different radials of the tree. The suspension was then shaken thoroughly and the microbial population assayed by the dilution plate method, using potato dextrose agar and Ken Knight's agar media. The plates were incubated at room temperature for seven days before final counts of the bacteria, actinomycetes and fungi were taken. The original rhizosphere suspension was evaporated to dryness over a water-bath and dry weight of the sample obtained. The total microbial population was calculated on the dry weight basis of rhizosphere sample. For comparison, soil samples collected at approximately the same depth as that of the selected roots, but away from the plants, were assayed for the microbial population.

The results indicate that the rhizosphere of growing roots of acid lime plants has nearly 150 times more of microbial population than that of the soil. The bacteria were 70 to 150 times more in the rhizosphere, the actinomycetes 4 to 20 times and the fungi 4 to 19 times more than those in the soil. The rhizosphere thus seems to favour better growth of bacteria than either fungi or actinomycetes. In these respects acid lime plant appears to be similar to some of the annuals like beans, sunn-hemp, etc.⁵ The streptomycin spray does not seem to significantly change the total microbial population as well as the component bacteria, actinomycetes and fungi, as indicated by the data obtained by examining the roots at periodical intervals after the spraying. The rapid growth of the streptomycin-sprayed acid lime plants may be due to causes other than the quantitative changes in the rhizosphere population.

Dept. of Agriculture, G. RANGASWAMI,
Annamalai University, V. N. VASANTHARAJAN,
Annamalainagar (S. India),
August 31, 1960.

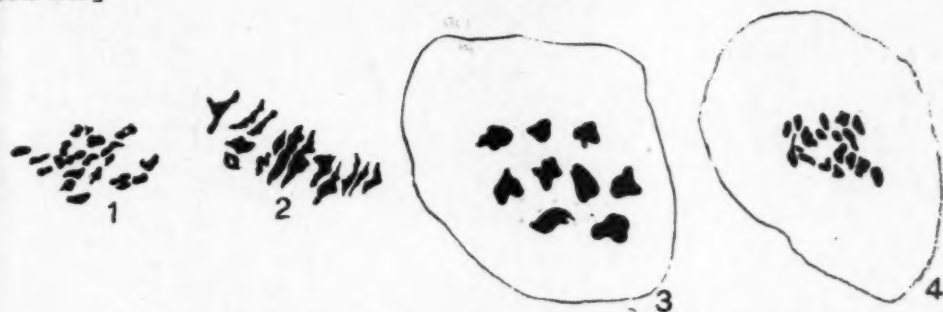
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MEIOTIC STUDIES IN SOME MALVACEOUS SPECIES

CYTOTAXONOMICAL studies of the tribe Malveae have been undertaken in this laboratory to bring out the details which may help in understanding some controversial points of systematology of the family Malvaceae. Stray cytological investigations of some wild species in the family Malvaceae have been done by several authors.¹⁻⁵ The present account deals with five species belonging to four genera. This investigation has brought out new facts regarding the number and configurations of the chromosomes in these species.

Cytological studies were made from acetocarmine preparations of pollen mother cells. Division in general was not found to be synchronous. Observations were taken at the diakinesis, M I and A I. In general appearance the configurations of bivalents, their size and in some cases even the number did not resemble the previous reports.

In *Malva sylvestris*, L., twenty-one bivalents were seen at M I in the PMCs. Some of the bivalents were always in groups showing secondary association. Twelve out of twenty-one bivalents appeared to be associated in four groups of three each. Thus it is suspected that this species may be a polyploid and the basic number may be 7. This is yet to be confirmed from the karyoanalysis of the root-tip mitosis. In *Malvastrum tricuspidatum* A. Gray, twelve bivalents were seen at diplotene. Three of the bivalents were seen to be associated with the nucleolus. In *Sida veronicaefolia*, Lamk. the diploid number reported was 14 or 56.⁴ But at M I in the present studies, only 14 bivalents were clearly seen (Fig. 2). On the other hand, in *Sida acuta*, Burm. nine bivalents were observed at M I (Fig. 3). For this latter species the previous report was 14 or 28.^{3,4} *Abutilon indicum*, Don.: the basic number in the poly-



FIGS. 1-4. Camera lucida drawings of: Fig. 1. MI in *Malva sylvestris*, Don. showing 21 bivalents ($\times 1,500$). Fig. 2. MI in *Sida veronicaefolia*, Lamk. showing 14 bivalents ($\times 1,500$). Fig. 3. MI in *Sida acuta* Burm. showing 9 bivalents ($\times 1,500$). Fig. 4. MI in *Abutilon indicum*, L. showing 18 bivalents ($\times 2,000$).

lobed series of this species was reported to be 7.³ The present study, however, revealed 18 bivalents at MI (Fig. 4). A consolidated account of the chromosome number determined is given below:

Name of the species	Chromosome number reported by previous workers	Authors	Present finding
1 <i>Malva sylvestris</i> , L.	2x/42	Skovsted, 1935	2x/42
2 <i>Malvastrum tricuspidatum</i> , A. Gray.	24	Skovsted, 1941	24
3 <i>Sida veronicaefolia</i> , Lamk.	14, 56	Skovsted, 1941	28
4 <i>Sida acuta</i> , Burm.	14, 28	Skovsted, 1935, 1941	18
5 <i>Abutilon indicum</i> , Don.	42	Skovsted, 1941	36

It is evident from the above table that *Malva sylvestris*, L. and *Sida veronicaefolia*, Lamk. have the somatic chromosome number which is multiple of 7. Hence, 7 can be taken as their basic number. In the cases of the other three species *Malvastrum tricuspidatum*, A. Gray., *Sida acuta*, Burm. and *Abutilon indicum*, Don., however, the somatic chromosome numbers are multiple of 6. Thus 6 and 7 both may be looked upon as the base numbers in this tribe. In the previous report the chromosome number of *Sida veronicaefolia*, Lamk. was found to be 14 and 56 whereas in the present investigation it has been found to be 28. This report, therefore, completes the polyploid series in this species. In the natural population, therefore, it appears that plants with 14, 28 and 42 chromosomes are found in the same way as in *Solanum nigrum* and several other species where also the diploids, tetraploids

and hexaploid forms within a single species have been reported. It may be interesting to find out the pollination frequency of the different forms in nature. In the case of *Sida acuta*, Burm. the present investigation contradicts altogether the previous findings. This indicates that *Sida veronicaefolia*, Lamk. and *Sida acuta*, Burm. have evolved from another species on parallel lines and their relationship is therefore remote. *Abutilon indicum*, Don. also falls more in line with *Sida acuta*, Burm. and *Malvastrum tricuspidatum*, A. Gray. than with *Sida veronicaefolia* Lamk. Detailed account on their breeding behaviour and their karyotype analysis is in progress. On the whole, it may be concluded that the tribe has several base numbers and the different species have evolved independently.

Dept. of Botany,
Patna University,
Patna, August 23, 1960.

R. P. ROY.
R. P. SINHA.

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CUP LEAF—A NEW LEAF MUTANT IN RAI (*BRASSICA JUNCEA* COSS)

A MUTANT, designated cup leaf because the upper leaf surface curved into a cup-like shape due to the incurving of the margin (Fig. 1), was observed by the author in his breeding material at the Government Research Farm, Kanpur, in 1955-56. The mutant bred true in the succeeding generations. To study its inheritance it was crossed with a normal type, Laha 101. The F_1 gave an intermediate expression,

The F_2 population segregated into normal, intermediate and cup leaf plants. While noting segregation some difficulty was, however, felt in classifying the plants into normal and intermediate classes but the differences between the intermediate class and the cup leaf plants were quite marked. The population was, therefore, classified into two groups, viz., Normal and Cup leaf. There were 1,300 normal and 254 cup leaf plants in F_2 . This gives a ratio of about 5.1 normal : 1 cup leaf. The observed ratio does not fit to any of the ratios expected on the basis of a monogenic or digenic segregation.



FIG. 1. Showing the cup leaf character in *rai*.

The ratio of about 5.1 normal : 1 cup leaf observed in F_2 above fits in very closely to a 54 normal : 10 cup leaf ratio to be expected on the basis of trigenic segregation (Chi-square 0.612 P. value between 0.50 and 0.30). This indicates an interaction of 3 genes. If, for the sake of simplicity, the genes for cup leaf characters are termed as recessive, then the presence of at least 2 recessive genes will be necessary to produce a cup leaf character. This explanation seems to be probable and is supported by the F_3 studies.

All the F_3 progenies of selected cup leaf F_2 plants bred true. Of the 9 F_3 families of the plants selected from the normal class, five progenies from F_2 plants with absolutely normal type leaf bred true while the remaining 4 pro-

genies segregated into normal and cup leaf plants as follows:—

TABLE I
Segregation of F_3 families

Families	Segregation		Total	Remarks
	Normal	Cup leaf		
1	27	21	48	9 : 7 (Chi-square 0.0)
2	225	37	262	54 : 10 (Chi-square 0.444 P. between 0.70 and 0.50)
3	267	52	319	54 : 10 (Chi-square 0.110 P. between 0.80 and 0.70)
4	56	4	60	15 : 1 (Chi-square 0.182 P. between 0.70 and 0.50)

Thus two progenies segregated into a 54 : 10 ratio, one segregated into 9 N : 7 C and one into 15 N : 1 C ratio. The population in families one and four is rather small. In family 1 the segregation into a 9 : 7 ratio is unusually quite perfect while other families also give a very close fit to the expected ratio. These results support the trigenic segregation of the normal and cup leaf characters. The number of F_3 segregating families is, however, very small and for further confirmation of these results a more intensive study will be made.

The mutant has also been observed to have relatively less shattering pods. This character may prove to be of economic importance in breeding varieties resistant to shattering.

Regional Res. Centre DHARAMPAL SINGH.
(Oilseeds and Millets),
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Kanpur, September 3, 1960.

FURTHER REPORT ON THE PEBRINE GERM OF *PHILOSAMIA RICINI* HUTT. AND ITS INFECTIVE CAPACITY ON *BOMBYX MORI* LINN.

Nosema bombycis Naegeli is the causative organism of pebrine disease of *Bombyx mori* Linn., the detailed life-cycle of which has been described by Stempell (1909).

Jameson (1922) has made the statement that '*Nosema bombycis* is a parasite of the eri worm' too. It is also popularly presumed that the germ of *P. ricini* Hutt. has a disastrous effect on *B. mori* Linn., so that rearing both the races in the same room is not considered advisable.

Steinhaus (1949) notes that cross-infections are relatively rare unless one deals with animals coming in the same minor taxonomic category (e.g., genus) or in closely related categories. *B. mori* and *P. ricini* do not come under the same genus and, in fact, not even the same

family. So, the problem of cross-infection was taken up for investigation.

A local multivoltine, the *Moria* and an imported univoltine, the *Chinese White* breed of *B. mori*, were used in the experiment. Mother moths from both *B. mori* and *P. ricini* were examined carefully for freedom from pebrine and disease-free eggs were used in the experiment. Pebrine germs of *P. ricini* were obtained from diseased moths and fed to the larvæ of *B. mori* of different ages by smearing the crushed material of diseased moths on leaves. Larvæ of healthy *P. ricini* were also similarly fed with the same diseased moth material. The number of feedings with the diseased material varied from one to ten in each group. The progeny of the *Moria* breed, which were given the maximum number of disease meals, were also reared for four generations continuously and in each generation two meals of diseased material were given. Specimens were examined by the smear method.

Larval or pupal mortality of *B. mori* was noticed in the first experiment, but in all the trials, examination under microscope revealed only bacterial infection and pebrine spores were not found either in dead or live specimens of *B. mori*. On the other hand, the group of *P. ricini* which received pebrine meal succumbed to the disease or the survivors revealed heavy infection. Typical pathogenic characters recorded by Talukdar (1960) could also be seen in this group. Groups of *P. ricini* which were not given a pebrine meal remained healthy.

Jameson (1922) found by experiment that the virulence of the disease in the case of *B. mori* increases from generation to generation. This holds good in the case of *P. ricini* infection according to our observations. But *Moria* breed of *B. mori* fed with pebrine germ of *P. ricini* repeatedly for four generations did not show signs of the disease.

The size of the pebrine spores of *P. ricini* is also different from that of *B. mori*. It generally ranges from 3.2 μ to 4.6 μ in length by 1.5 μ to 2.1 μ in width in the case of *P. ricini*, while the size of *N. bombycis* is given by Kudo (1946) as 3 to 4 μ by 1.5 to 2 μ .

The above results lead to the conclusion that the pebrine germ of *P. ricini* cannot infect *B. mori*.

If Jameson's (1922) statement is correct, the germ of *P. ricini* fed to *B. mori* would have developed the same disease in *B. mori* also. The present results lend support to the author's (1960) inference that the pebrine germ of *P. ricini* might be different from that of *B. mori*.

Regional Sericultural
Research Station,
Titabar (Assam), September 9, 1960.

J. N. TALUKDAR.

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PRELIMINARY TRIALS WITH AN ENTOMOGENOUS BACTERIUM, *BACILLUS THURINGIENSIS* BERL., NEW TO INDIA

SINCE the successful control of Japanese beetle in U.S.A. by microbial means, entomogenous spore-forming bacteria have received much attention on account of their great potentialities for insect control.¹ Of the several organisms studied none probably has offered as much promise as has the crystalliferous spore-forming bacterium, *Bacillus thuringiensis* Berl., which is effective against a wide range of destructive caterpillar pests in many countries.²

With a view to studying the action of *B. thuringiensis* on the common insect pests affecting cultivated crops in India a culture of the bacterium was brought from U.S.A., and preliminary trials were started in Agricultural College and Research Institute, Vellayani, Kerala State. Results of both laboratory and field trials have revealed that the caterpillars of *Plusia peponis*, *Margaronia indica* and *Glyphodes* sp., were highly susceptible in all stages of growth. In many cases cent per cent. mortality was observed within 24 to 48 hours. Though the early stages of *Nephantis serinopa* and *Spodoptera mauritia* were susceptible, the older larvæ showed some resistance. In all these cases typical symptoms of death due to bacterial infection were noticed. The bacterium was cultured from the dead insects and the identity was confirmed both by morphological features and pathogenicity tests. The bacterium had no deleterious effect on the honey-bees. Some of the common parasites and predators like *Trichospilus pupivora*, *Apanteles* sp., *Microbracon* sp., *Scymnus* sp., were not affected by the bacterium under laboratory and field conditions.

Large-scale field trials using this bacterium are in progress.

Entomology Department,
Agricultural College and
Research Institute,
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October 22, 1960.

G. RENG AYYAR.

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CODEINE PHOSPHATE AS A PRETREATING AGENT

CODEINE phosphate, a phosphate derivative of the plant alkaloid codeine (extracted from the unripe heads of poppy), was tried as a pretreating agent.

The root tips of *Pisum sativum* Linn. (BR. 2) were dipped for 2½ hours in 0.2% aqueous solution of codeine phosphate, at room temperature (27°C.). The tips were then transferred to 1:3 acetic alcohol and permanent preparations were made following the usual aceto-carmine squash method. Heating was avoided and mounting was done in Euparal. Camera lucida drawings of the various stages of mitosis were taken from the permanent slides.



Fig. 1.

FIG. 1. Camera lucida drawing of early anaphase showing twenty-eight chromosomes.

As shown in the figure, the effects of this pretreating agent has been (1) the disorganisation of the spindle; (2) the contraction of the chromosomes; (3) the clarification of the primary constrictions and (4) the adequate separation of the chromosomes.

It would appear, therefore, that this chemical can be used instead of paradichlorobenzene, coumarine, 8-oxyquinoline, etc.

The authors wish to thank the Director, I.A.R.I., for kindly sending the seeds and the Head of the Department of Botany of L.S. College for providing the necessary facilities.

L.S. College, AKHAURI BALRAM PRASAD.
Muzaffarpur, Bihar, UMAKANT SINHA.
September 9, 1960,

OBSERVATIONS ON STOMATA IN COLEOPTILE OF *ORYZA SATIVA* L.

DURING the course of anatomical studies, including different species of *Oryza*, in progress at the Central Rice Research Institute, observations were made on stomata in different parts of the plant. It has been found that the shape of stomata, observed on the coleoptile, presented a different appearance from that on the leaf. This has been confirmed from seedlings of a large number of rice varieties.

The guard cells of stomata on the leaf of the rice plant are dumb-bell-shaped, being bulbous at the two ends and straight in the middle (Fig. 1), whereas the guard cells of stomata

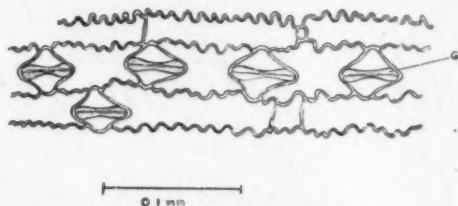


FIG. 1. Stomata in leaf of *Oryza sativa* L. showing dumb-bell-shaped guard cells; G, guard cell.

on the coleoptile are kidney-shaped (the normal type) and they continue to retain more or less the same shape throughout, till the coleoptile begins to wither away. The accessory cells in the stomata of coleoptile are not always distinct from the epidermal cells. Sometimes only one of the two accessory cells is distinct and in some cases none could be recognised (Fig. 2).

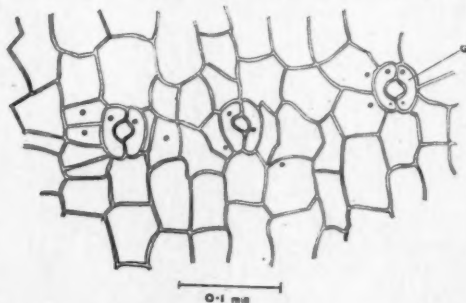


FIG. 2. Stomata in coleoptile of *Oryza sativa* L. showing kidney-shaped guard cells; G, guard cell.

The dumb-bell-shaped type is characteristic of Gramineae and Cyperaceae, whereas the kidney-shaped type (the normal type) is characteristic of other angiosperms (Esau, 1953 and others). Marked variations in the number and size of stomata do occur, as observed by a number of

investigators, not only in the different varieties of the same species but also in the same varieties grown under different conditions. But variation in the shape or structure of the stomata on the same plant, as observed here (both dumb-bell-shaped and kidney-shaped guard cells), does not seem to have been recorded. According to Flint and Moreland (1946) and Esau (1953) working on sugarcane, the guard-mother cell divides to form two guard cells which during enlargement first become kidney-shaped and then assume their characteristic dumb-bell-shape. Kaufman (1959) working on leaf histogenesis of *Oryza sativa* L. also noted a similar developmental stage.

Central Rice Research Inst., R. H. RICHARIA.
Cuttack-4, August 27, 1960. J. K. ROY.

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MODIFICATION OF EJACULATORY DUCT IN *EMPOASCA DEVASTANS* DIST.

THE study of the reproductive system of jassids has been a neglected subject so far. A detailed study of the reproductive system of cotton jassid revealed some very interesting features. It was found that the ejaculatory duct in *Empoasca devastans* Dist. has a peculiar modification.

Testis (Tes) (Fig. 1).—There is a pair of testis lying in the abdominal cavity of the third

follicles which are globular in shape and open separately into the vas deferens (Vd) of their side by small vasa efferentia (Ve). The testicular follicles have spermatogonia in different stages of their development.

Vas deferens (Vd).—There is a pair of these tubular structures lying below the alimentary canal; these along with the testes are mesodermic in origin. After receiving the testes, the vasa deferentia converge backwards to open separately into the bulbous part of the ejaculatory duct, just beneath the alimentary canal. Functionally they serve as simple conduit for the spermatozoa released from the testes.

Common ejaculatory duct.—It is stated to be an unpaired tube in its embryonic stage in insects but at its anterior end it may be frequently forked specially when accessory glands arise from it (Snodgrass, 1935). In this insect it is of a very peculiar nature and consists of three parts—the anterior part is a bulbous body in which the two vasa deferentia open; the median part comprises two narrow tubes which converge posteriorly to open into the third part which is an unpaired tubular structure. It appears that the posterior unpaired tubular structure is the main body of the ejaculatory duct, and the median-paired tubes are its persistent forked ends from which the accessory glands arise nearly at the level of the posterior border of the bulbous body which might have been formed by the union of the vasa deferentia.

Accessory Glands (Ac Gl).—There is a pair of long tubular accessory glands lying lateral to the ejaculatory duct and arising from the latter, above midway.

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A NOTE ON THE CRYPTOGRAMS OF BHOPAL

THE Cryptogams of Bhopal plateau and its adjacent parts are very imperfectly known. Except for a few papers which deal with the flora of the adjacent regions (Pande and Shrivastava, 1952; Bapna, 1958) this region seems to have received little attention in the past. The present note is based on collections maintained for the last few years.

The Bhopal plateau (alt. 1,800-2,000 ft.) is mostly hilly, the annual average rainfall is 30 to

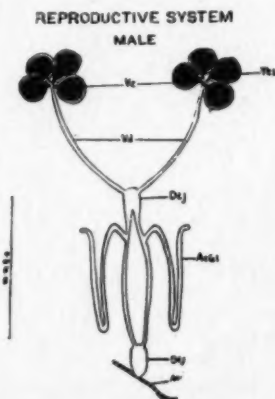


FIG 1

visible segment dorsolateral to the alimentary canal. Each testis consists of four testicular

TABLE I
Liverworts collected from Bhopal plateau

Hepaticae	Localities	Habitat	Distribution in India
Anthocerotales:			
<i>Anthoceros himalayensis</i> Kashyap (tuber forming)	Very common, Bhadbhada and Delawari streams	In shade on clayey soil along banks	Mt. Abu, W.H., S.I., E.H.
<i>Anthoceros punctatus</i> L.	.. Common, Delawari	On gravel and moist soil	E.H. (Assam), Lucknow*
<i>Notothylas indica</i> Kashyap	.. Common	On moist ground	Pachmarhi, W.H., S.I.
Marchantiales:			
<i>Plagiochasma intermedium</i> L. et G.	do.	On moist dilapidated walls	do. (Pathankote)
<i>Asterella angusta</i> (St.) Kachroo	Very common	On moist clayey soil on bank of streams	do. E.H., Mt. Abu
<i>Cyathodium barode</i> Chavan	.. do.	In sheltered places on walls	Mt. Abu, Pachmarhi, S.I.
<i>Riccia discolor</i> L. et L.	.. Common	On moist ground and gravel paths	Mt. Abu, Pachmarhi, S.I., W.H., E.H.
<i>R. gangetica</i> Ahmad	.. Very common	do.	do.
<i>R. billardieri</i> Mont. et N.	.. do.	do.	do.
<i>R. plana</i> Taylor	.. Common	do.	Mt. Abu, S.I., E.H.
<i>R. tuberculata</i> Pande et Udar	.. Very common	do.	Mt. Abu, S.I.
<i>R. melanospora</i> Kashyap	.. Common	On niches of walls in exposed places	W.H. (Punjab plains and Lucknow)
<i>R. sp.</i> †	.. Not common	On silt of banks of ponds	..

Abbreviations: W.H. = Western Himalayas; E.H. = Eastern Himalayas; S.I. = South India; Mt. Abu. = Mount Abu.

* See Handoo, O. N., *Curr. Sci.*, 1959, 28, 470.

† Probably *R. crystallina*. On account of scanty unfertile material no identification was possible.

TABLE II
Cryptogams collected from Bhopal plateau

Types	Localities	Habitat
Licopodiales:		
<i>Selaginella</i> Sp.	.. Delawari forest	On moist ground in shade
Ophioglossales:		
<i>Ophioglossum fibrosum</i> Schum.	Common	Moist hilly slopes during rainy season
<i>O. vulgatum</i> L.	.. Less common	do.
<i>O. graminum</i> Willd.	Rare	do.
<i>O. nudicaule</i> L.	.. Common	do.
Filicales:		
<i>Actinopteris dichotoma</i> Bedd.	do.	On rocks and old walls
<i>Adiantum caudatum</i> L.	do.	Slopes of hill in shade
<i>A. philippense</i> Linn. (<i>A. lunulatum</i> Harm.)	do.	do.
<i>Pteris longifolia</i> L.	.. do.	Crevice of walls and wells
<i>Cheilanthes tenuifolia</i> Sw.	do.	On hills on rocks
<i>Marsilea quadrifolia</i> L.	do.	In water, near banks of streams and ponds
<i>Azolla pinnata</i> R.Br...	Lower lake	In still freshwater

50 inches. The soil is mostly red gravel and interspersed at some areas with black cotton soil. The rocks constituting the hills are metamorphic and sandy; and the vegetation is of mixed deciduous type.

Table I shows that out of the twelve species listed, *Anthoceros himalayensis*, *Asterella angusta*, *Riccia gangetica* and *Riccia discolor* have an all-India distribution. *Notothylas indica* comes next, though unrepresented in E.H. and Mt. Abu. Seven species are represented in the Ghats, seven in Western and six in Eastern Himalayas and ten in South India. Bhopal plateau, thus, represents a mixture of the hepatic flora from all the four corners of India.

The authors are thankful to Dr. P Kachroo for his valuable suggestions and help and also for going through this note.

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Bhopal, September 26, 1960.

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REVIEWS

An Introduction to Stochastic Processes. By M. S. Bartlett. (Cambridge University Press, London N.W. 1), 1960. Pp. 312. Price 22 sh. 6 d.

It is a privilege to write about the book entitled "An Introduction to Stochastic Processes" by my teacher and guide Professor Bartlett. When it appeared first in 1955, it was the only book on stochastic processes with special preference to methods and applications. The only systematic account, from a stochastic point of view, of some physical processes was perhaps the famous article by Dr. Chandrasekhar in the *Reviews of Modern Physics*. Until recently the theory of stochastic processes was treated as a close preserve of pure mathematicians who regarded it as a branch of measure theory. Doob's classic work was written in a language quite unfamiliar to physicists and even physicists acquainted with the theory of probability did not consider stochastic processes as part of mathematical physics. This seems particularly surprising since the probabilistic interpretation of quantum mechanics is as old as quantum theory itself.

The recent interest in the application of stochastic processes stemmed from three different sources.

- (1) Biology and the theory of population growth;

- (2) Cosmic ray cascades, and

- (3) the theory of turbulence and problems of correlation arising therefrom.

Even before the interest in actual applications arose, the theory of Markoff processes had reached a comparatively advanced stage; so also that of analytical operations in random processes. Hence suitable adaptations to actual physical problems came as a natural consequence to these developments. Professor Bartlett's book was written at this critical period in the development of the theory when new techniques were devised from a basic mathematical structure. His book starts with a rather conventional summary of the standard probabilistic concepts but we are rapidly led into the theory of random sequences and Markoff chains written in such lucid style that one may perhaps be led to the belief that all this is just a standard extension of the concept of an aggregate of random variables. This is erroneous if we remember that the simplest derivation of the

Furry process was made as late as 1937 in an original contribution to the *Physical Review* and Kolmogoroff wrote a fundamental paper on branching processes a few years later. The chapter on random processes in continuous time is written in a style readily acceptable to the physicist. The sections on recurrence and first passage times are perhaps some of the best in this book. Among the fields of application which stimulated new techniques of the theory are problems relating to queues, population growth and more generally, point processes. A good summary of the method of regeneration points, product densities and the use of the characteristic functional is given in the course of dealing with the problems themselves.

As regards the mathematical aspects of the book, it is quite clear that Professor Bartlett was influenced by the work of his associate Dr. Moyal who contributed a very important paper in the symposium of the Royal Statistical Society held in 1949. In a sense the proceedings of that Symposium perhaps started Professor Bartlett on the idea of writing the book. The chapter on limiting stochastic operations is mainly based on Moyal's article.

The role of statistical ideas in hydrodynamics and the importance of the spectral theory of random functions has long been realised by applied mathematicians. Though Professor Bartlett's chapter on stationary processes does not lead to the problems of turbulence, it presents a harmonic analysis in a usable form.

The chapters on communication theory serve as an introduction to a subject which is now claiming to be complete in itself. This chapter was written at about the time when Shannon's celebrated contributions were just becoming familiar.

What we have till now described refer to the probabilistic aspect of the book. There lies the problem of statistical inference in stochastic processes theory. The last chapters of the book refer to this aspect.

The titular description of the book as an "introduction" is an understatement characteristic of the inherent modesty of a great mathematician and teacher. There is no doubt the book has already set many physicists thinking of treating many dynamical processes with a random element in their structure as stochastic processes. As a physicist, I hope that the next

edition will include new applications and if possible the probabilistic interpretation of quantum mechanics. The new paper back reprint will be welcomed in countries where book-buying is yet to become a habit among young workers and scientists.

ALLADI RAMAKRISHNAN.

Introduction to Colloid Chemistry. By Karol J. Mysels. (Interscience Publishers, Inc., New York), 1959. Pp. xv + 475. Price \$10.00.

To colloid chemists, Prof. K. J. Mysels needs no introduction. He is not only an active worker in several fields of colloid chemistry but also a lucid writer of several text-books and popular articles in chemistry. Being the author of 'Text-book errors', he has taken very good care to avoid the common errors in his book. The book is intended for the undergraduate who wants to be introduced to the subject of colloid chemistry with the usual knowledge of physics and chemistry, and also to the industrialist who is mainly interested in the application of the knowledge to the industry. On the whole the author has achieved his objective. He has avoided to a large extent the mathematical aspect of the subject to keep up the interest of the reader and maintaining the continuity of thought without entering into the details. For the advanced student however, the book makes only a refreshing reading. A mathematical treatment of important equations, as an appendix, would have been very useful even to an advanced student. The author has employed different symbols to denote the physico-chemical quantities. This has resulted in the use of unfamiliar symbols causing some confusion to the reader. In the opinion of the reviewer, the use of the common symbols would have given the reader an added advantage, eliminating the frequent reference to the list of symbols at the end of the book.

The book has been divided into XX Chapters. Each chapter ends with the summary, references and problems connected with the chapter. The first five chapters deal with the general properties of colloids like structural elements, sedimentation rate, flocculation, diffusion and Brownian motion. The next two chapters deal with the colligative properties and sedimentation equilibrium. Chapters VIII and IX deal with sorption and its application to a variety of phenomena like protective action, sensitisation, chromatography, etc., involving the process of sorption. Fluctuations and rubber

elasticity, preparation of colloids and rheology form the subject-matter of Chapters X-XII. Nearly hundred pages are devoted in dealing with the electrical properties of colloids under the headings: electroneutrality, the double layer, electrokinetics and charge effects in colloids. The optical properties are dealt with in the last three chapters where refraction, schlieren, interference, and scattering by colloids are discussed.

In many respects, the author has struck a new and well-thought-out plan in the arrangement and presentation of the subject-matter. The book is a valuable guide both for the teachers and the students in the colleges in understanding the principles of colloid chemistry.

M. R. A.

Fast Neutron Physics—Part I. Edited by J. B. Marion and J. L. Fowler. (Interscience Publishers, Inc., New York), 1960. Pp. 983. Price \$29.00.

This publication styled as Part I contains 24 contributed articles which have been grouped under four sections: (1) Neutron Sources; (2) Recoil Detection Methods; (3) Detection by Neutron-Induced Methods and (4) Special Techniques and Problems.

The discovery of the fission enhanced the importance of neutrons tremendously and modern atomic reactors based on neutron multiplication compete with any other source of power in meeting world's energy needs. The neutrons that we meet with in this field are slow neutrons, about which much has been written. The present volume, however, concerns itself with fast neutrons falling in the range between 1 KeV neutron energy to several hundred MeV.

The four sections comprising Part I are concerned with experimental techniques. The first section discusses neutron sources, both radioactive sources and those resulting from bombardment with artificially accelerated particles. Sections II and III are concerned with neutron detection by recoil methods and by neutron-induced reactions respectively. In Section IV are a number of papers on special techniques and problems such as time of flight techniques, flux measurements, target preparations, neutron shielding both for experimental as well as radiation protection purposes, electronic computer methods and general health physics problems when handling neutrons.

The volume is meant to be a reference work and will be of interest and use not only to

research scientists, but also to reactor engineers and health physicists.

A. J.

The Chemistry of Natural Products. Edited by K. W. Bentley. Vol. V. *The Carbohydrates.* By S. F. Dyke. (Interscience Publishers, New York, London), 1960. Pp. 232. Price \$4.75.

As a text on the constitution of carbohydrates, the book offers quite brief and succinct reading in parts with relevant information well emphasized. But the paucity of information in many essential sections of the book tempts one to wonder if the book as a whole would be of much use to any student appearing for an examination on a fairly advanced level, for instance, the M.Sc. students of Indian Universities. This criticism may be elaborated by the following examples:

In a discussion on the methods of chain-lengthening of aldoses (p. 18) there is no written explanation of the formulae to which reference is made in the text.

"Sowden method (12). This is illustrated in XXXIX to XLII.

Ruff method. This is one of the most useful methods (XLVII to XLVIII).

MacDonald-Fischer method (8). This is very useful in many cases (XLIX to LI).

.....
Addition of one carbon atom (LV to LIX)."

While numerous pages are left blank in the book elsewhere, the brevity achieved in the instances described above is meaningless. With better planning, the experimental conditions, reagents and other details could be mentioned and explained in greater detail. The discussion on Hudson's isorotation rules does not present even a single illustration for the rules propounded. The definition of Molecular rotation though technically correct is different from what is mentioned in most other text-books and monographs. Mention should have been made of this difference.

The section on derivatives of the monosaccharides is well listed with the usual derivatives like the methyl, benzyl, trityl ethers, isopropylidene derivatives and phosphates. The preparation and properties of these compounds are described. However, under the heading Sulphates (p. 78) there is a void!

There are numerous other trivial mistakes like the erroneous formula on p. 9. But the criticisms levelled against the volume under review stem mainly from two considerations. That these would help the editor in preparing

a better volume in the series on other topics yet to come. Secondly, a more necessary consideration, in so far as Indian students are concerned, a complete text-book like that of the Fiesers' on Organic Chemistry incorporating most of what this monograph dishes out, is available for much nearly the same price.

B. S. T.

The Plasma Proteins, Vol. 1. Edited by F. W. Putnam. (Academic Press, New York and London, India: Asia Publishing House, Bombay-1), 1960. Pp. xv + 420. Price \$12.50.

The book under review, which is the first of two volumes on Plasma Proteins edited by F. W. Putnam, deals with the isolation, characterization and function of an important class of proteins found in the plasma. It gives an authoritative account of the different aspects of plasma proteins which at present is found scattered in different research publications. The introductory chapter written by the editor himself gives a bird's eye view of the contents of this volume and is followed by an article of R. B. Pennell dealing with the fractionation and isolation of the various components by means of precipitation methods. The latter also includes a section giving brief account of the theoretical principles involved in the adoption of such procedures. Special emphasis has been placed on low temperature fractionation by thanole so widely adopted after its first application by E. J. Cohn and there is also a well compiled set of appendices, summarizing the data obtained by standard methods.

Analytical and preparative electrophoresis of human serum proteins is presented by G. R. Cooper and this is again highlighted by a comprehensive tabulated statement bringing together in one place all the electrophoretic and ultracentrifugal data on this subject. E. A. Peterson and H. A. Sober have dealt with the chromatography of plasma proteins in the next article with particular reference to the column chromatographic technique. A table containing specific procedures along with critical comments has also been included at the end of this chapter.

The amino-acid composition of several of the important plasma proteins, the known data on the terminal amino-acid sequences of albumins and an exhaustive compilation of molecular parameters such as electrophoretic mobility, molecular weights and sedimentation constants have been included in the next article by R. A. Phelps and F. W. Putnam. Exhaustive

accounts on plasma albumin as well as on gamma globulin and antibodies have been presented by J. F. Foster and R. R. Porter, respectively, in the subsequent chapters, while H. G. Kunkel in a later article has dealt with the immunochemical and ultracentrifugal aspects of macroglobulins and antibodies of high molecular weight. R. J. Winzler—wrongly spelt as R. H. Winzler in the list of contributors as well as in the table of contents—has given an excellent account of glycoproteins covering the extensive literature and has included a table giving all available data on the subject. The last chapter on metal binding plasma proteins and cation transport by C. B. Laurell deals with the interaction of metal ions like iron, copper and zinc with plasma proteins. It contains, in addition, methods of isolating them and a discussion of their biological significance.

As F. W. Putnam has stated in his introduction, "much is to be expected in the way of discoveries in the plasma proteins in coming years", and "one aim of this book is to stimulate exploration by charting the developing areas and directing attention to the 'vast unknown'". The present volume has served the above purpose exceedingly well and all readers interested in this subject will look forward with eagerness to the early publication of the second volume dealing with the biosynthesis, metabolism and alterations in disease, of plasma proteins.

P. S. SARMA.

Current Bibliography for Aquatic Sciences and Fisheries, Vol. 3, Part 1. Compiled by F.A.O. Fisheries Biology Branch. (Published by Taylor and Francis Ltd., London, E.C. 4). Price for Part £ 0-17-6; Volume of 12 Parts £ 9-0-0.

This volume, the first printed one, is a continuation of Vols. I and II of the series issued in mimeographed form during 1958 and 1959 and is a very valuable asset to workers in the disciplines of aquatic biology and fisheries. Nearly half of this part is taken up with an explanation of the coverage and arrangement, consolidating the "Explanatory Notes" issued time to time in the earlier versions of the Bibliography. What strikes an Indian reader foremost is the almost total absence of coverage of Journals and papers published in India and in the South-East Asia region in general. Only the *Indian Journal of Fisheries* and 8 papers published therein find a place among about 628 papers listed! Quite a large number of relevant papers in the disciplines concerned are to be found in other Journals such as: *Proc. Ind.*

Acad. Sci., B., J. Indian bot. Soc., Curr. Sci., Proc. Nat. Inst. Sci. India, etc. It is hoped that this lacuna will be filled up. Regarding the arrangement of references, an alphabetical order would have been better and more useful as they have not been placed under different heads. However, these remarks are not to detract the importance of the work. The publishers deserve all thanks for bringing this Bibliography out. The price will be found to be too prohibitive by individual workers.

R. SUBRAHMANYAN.

Geology of India and Burma. By M. S. Krishnan, IV Edition. [Higginbothams (Pt.) Ltd., Mount Road, Madras], 1960. Pp. 604. Price Rs. 22-50.

It is a pleasure to see the Fourth Edition of this book brought out so soon after the publication of the third Edition in 1956. The book has been divided into 20 chapters. The first chapter deals essentially with the major Geological and Geographical features of the Indian Continent. The second chapter gives a concise account of the structures and the major tectonic features of India. The main orogenic belts have been described and the entire thing is incorporated in a neat sketch. The third chapter deals with the principles of Indian stratigraphy, their equivalents in standard stratigraphical scale and certain major stratigraphical peculiarities in India.

Three chapters 4, 5 and 6 are devoted to the Archæans of India, 4th dealing comprehensively with the Archæan of Peninsular India in which an excellent summary of the work of the Geological Surveys has been incorporated, indicating the main problems of Archæan geology. The fifth chapter deals with the Archæan of extra-Peninsular India. A separate chapter deals with the economic importance of the Archæan rocks giving a summary of the most important mineral deposits found in these rocks.

The remaining fourteen chapters are devoted to the various systems, each chapter dealing with one of the systems. In dealing with the stratigraphy of each of the systems, at the beginning, their European equivalents are given which will at once make their positions very clear to the students.

A large number of maps, sketches and sections have been included which enhances the value of the book not only to the advanced students of Indian Geology, but also to the Research workers. A welcome change from the previous edition is the inclusion of the Geological Map of India in black and white in

four different parts. It would have been ideal if the attempts of the author to include a coloured Geological Map of India in one sheet had materialised.

This book represents a summary of the great discoveries made in Indian Geology during the last one hundred years, and as such has become an invaluable guide to all Research workers in the field of Indian Geology. Coming as it does from the authoritative pen of the distinguished author it must readily find a place in all University libraries. The cost has been kept fairly low, and both the author and the publishers must be warmly congratulated on this excellent production.

M. R. S.

Monographs for Teachers : No. 1—Principles of Electrolysis. By C. W. Davies. Pp. 30, Price 3 sh. 6 d.; No. 2—*Principles of Oxidation and Reduction.* By A. G. Sharpe. Pp. 30, Price 3 sh. 6 d.; No. 3—*Principles of the Extraction of Metals.* By D. J. G. Ives. Pp. 57, Price 6 sh.; (The Royal Institute of Chemistry, 30, Russell Square, London W.C. 1).

Index of Chemistry Films. (The Royal Institute of Chemistry, London W.C. 1), 1959. Pp. ix+150. Price 5 sh.

The developments that have taken place in the different branches of science during the last two decades or so, have been so rapid that it is the experience of teachers who teach the subject at a more advanced level, that his students will have to "unlearn" a good deal of what he had been taught at a more elementary stage. Especially is this so in chemistry. In this context it is an extremely useful venture that the Council of the Royal Institute of Chemistry has undertaken to issue "concise and authoritative accounts of selected well-defined topics in chemistry" for the guidance of the teachers of the subject in High School classes. The *Monographs for Teachers* written by experienced Professors and Readers attached to University Colleges will be greatly welcomed by all science masters. Advanced students also will find in these booklets much that will be of value to them.

Another publication by the Royal Institute of Chemistry (*viz.*) the *Index of Chemistry Films* aims to bring together in one volume relevant details concerning 800 films and 200 filmstrips. These cover the requirements of schools, technical colleges and training departments of industrial firms. The list includes a

variety of instructional films ranging from the elementary to the research type.

Proceedings of the Symposium on Thyro-Gonad-Adrenal-Pituitary Relationships Held at New Delhi in 1959. (Bulletin of the National Institute of Sciences of India, New Delhi, No. 17), March 1960. Pp. xi+131. Price Rs. 10-62 nP.

The interrelationships between endocrine glands and their regulatory mechanisms are still fields of experimentation. While broad generalizations on the role of endocrine secretions in the maintenance of homeostasis can be made, there are many intricate and vexed problems which still defy solution. With the advances in methodology and the application of newer biochemical and histological techniques including radioactive tracer studies, it has been possible to unravel certain metabolic and functional aspects of some hormones.

The proceedings of the symposia highlight the present state of our knowledge pertaining to interrelationships existing between the thyroid, gonadal, adrenal and pituitary hormones. The subjects discussed cover a wide area of biological interest. The influence of those hormones on reproductive physiology, the enzymatic activities of some hormones, the hormonal regulation mechanisms as affected by clinical disorders, and the use of tracer technique for evaluation of function and interrelationship of thyroid with the gonads and pituitary are a few of the many interesting topics presented in this volume.

M. SMR.

Biennial Review of Anthropology 1960. Edited by Bernhard J. Seigel. (Stanford University Press, California), 1959. Pp. x+273. Price \$ 6.00.

Participating in the discussions during the Wenner-Gren Foundation Symposium on Anthropology in the summer of 1952, Nadel focussed attention on the fact that the literature available to an anthropologist was growing so fast that no single person could hope to master it even in his own field of research. Therefore, he pleaded: "We need a book that, year by year, will summarize the ethnographic work that has been carried out—the mere factual material, the theoretical advances made or our hypotheses, and the conclusions that have been suggested" (*An Appraisal of Anthropology Today*, edited by Sol Tax et al., 1953, pp. 89-95). The Wenner-Gren Foundation issued a Yearbook of Anthropology in 1955, a bulky volume of about 850

pages containing original papers. The Editor of the book under review explains that this is the first volume of a separate series which will appear at short intervals. "It is intended to describe and summarize in a systematic manner the more noteworthy papers and monographs published since 1955 in five fields of major current interest; social and cultural change, physical anthropology, linguistics, social organization, and psychological dimensions of culture" (p. v). This Review, we believe, more than the Yearbook issued by the Wenner-Gren Foundation in 1955 meets the kind of demand Nadel and numerous other anthropologists have felt in recent years.

The book consists of seven chapters:

(1) Recent Advances in Physical Anthropology (G. W. Lasker); (2) Culture Change (Louise, S. and George D. Spindler); (3) Psychocultural Studies (J. J. Honigsmann); (4) Social Organizations (Harry Basehart); (5) Recent Trends in Soviet Anthropology (Lawrence Krader); (6) Language (Floyd Lounsbury), and (7) Political Anthropology (David Easton).

The coverage of published materials is extensive. Thus Lasker lists 412 publications of the years 1955-57 covering over a dozen subjects including the process of human evolution, primatology, race, blood groups, abnormal haemoglobin, dermatoglyphics, taste sensitivity, growth, chemical anthropology and blood-pressure. Other contributors have also similarly covered the research publications within their respective fields. But whereas some of the contributions read like bibliographies or guides to reading, others are more substantial and provide the reader a good idea of trends not only in the titles of books and papers but also in the contents and methods of research. Examples of the latter type of paper are provided by Basehart's and Easton's essays. The Editor tells us that Easton is not a professional anthropologist but a political scientist. This is all the more the reason why we must make particular mention of his excellent paper which is a discussion and not an annotated inventory. He cites only 25 references but concludes his paper by giving brief summaries of about 40 publications which are arranged in groups.

The book under review is a handy and very useful volume. We have only one criticism to offer and also two suggestions to make. The method, adopted in this book, of mentioning full particulars of the journals in which the papers cited have appeared [e.g., Beattie, J. H. M., *Africa*, 26: 265-76 (1956)] without giving the title of the paper is very unsatisfactory. We

suggest that future issues of the *Biennial Review* should change this style of reference. Care should also be taken—and this is our second suggestion—to impress upon the contributors that what the readers will appreciate will be discussions of trends in research rather than mere inventories, no matter how comprehensive. In the end we warmly recommend this book to all interested readers, particularly the professional anthropologists who will find it very valuable.

T. N. MADAN.

ISI Handbook of Quantities, Conversion Factors, Formulae and Tables. (Indian Standards Institution, 9, Mathura Road, New Delhi-1), 1960. Pp. 163. Price Rs. 7-50 nP.

The Indian Standards Institution had taken upon itself the task of bringing out a Handbook which will be useful to the student population of India at this time when the country is switching over from the age-old multi-form systems of weights and measures to the uniform metric system approved by an act of parliament. The fulfilment of this task has been quite laudable.

The Handbook is divided into three sections, (A) Quantities, Units and Conversion Factors, (B) Physical and Chemical Constants and (C) Mathematical Formulae and Tables.

Section A contains a wealth of definitions and data on physical quantities in Mechanics, Heat, Light, Sound, Electricity, Magnetism, etc. Section B contains a large number of Tables on Astronomical and Geodetic data; Properties of elements, gases, liquids and solids; data pertaining to structural engineering, aeronautics and telecommunication, etc. Section C contains useful formulae in Algebra, Trigonometry (Plane and Spherical), Geometry and Calculus. There are also the usual Tables of logarithms, squares, cubes, square-roots, reciprocals, etc., trigonometrical functions; exponential and hyperbolic functions and normal probability integrals.

This comprehensive book of constants, formulae and tables should prove useful to all students of science, engineering and technology and in fact it should be in the pocket of every student belonging to these disciplines, but from the price it seems that the pocket has to be emptied first before making room for the book.

Books Received

The Chemical Society Annual Report on the Progress of Chemistry, Vol. LVI, for 1959. (The Chemical Society, Burlington House, London W. 1), 1960. Pp. vi + 476. Price £ 2,

Periodicals in the Chemical Society Library. (The Chemical Society, Burlington House, London W. 1), 1960. Pp. 48. Price 5 sh.

Pure Mathematics, Vol. I: Calculus; Vol. II: Algebra, Trigonometry and Co-ordinate Geometry. By F. Gerrish. (Cambridge University Press, London N.D. 1), 1960. Pp. xxv + 361; Pp. xxi + 363-758. Price 25 sh., 35 sh. respectively.

Indian Essential Oils—A Review. By A. K. Menon. (Council of Scientific and Industrial Research, New Delhi-1), 1960. Pp. 89. Price Rs. 7.

Discovery Reports, Vol. XXX: Studies on Physalis (L.). Part I: Natural History and Morphology. By A. K. Totton; Part II: Behaviour and Histology. By G. O. Mackie. (Cambridge University Press, London N.W. 1), 1960. Pp. 301-408. Plates VII-XXVIII. Price 70 sh.

Progress in Inorganic Chemistry, Vol. 2. Edited by F. Albert Cotton. (Interscience Publishers, New York-1), 1960. Pp. 399. Price \$ 10.50.

Metabolic Pathways. Edited by David M. Greenberg. (Academic Press, New York-1), 1960. Pp. xv + 572. Price \$ 18.00.

Organic Analysis, Vol. 4. Edited by J. Mitchell, Jr., I. M. Kolthoff, E. S. Proskauer, A. Weissberger. (Interscience Publishers, New York-1), 1960. Pp. vii + 429. Price \$ 13.50.

Comparative Biochemistry—A Comprehensive Treatise, Vol. I: Source of Free Energy. Edited by Marcel Florkin and Howard S. Mason. (Academic Press, New York-1), 1960. Pp. xxv + 590. Price \$ 18.00.

Industrial Electric Furnaces and Appliances (Second Edition, Revised and Enlarged). By P. V. Paschkis and John Persson. (Interscience Publishers, New York-1), 1960. Pp. xvi + 607. Price \$ 24.00.

Infra-Red Methods—Principles and Applications. By G. K. T. Conn and D. G. Avery. (Academic Press, New York-1), 1960. Pp. viii + 203. Price \$ 6.80.

General Zoological Microtechniques. By Frances M. Weesner. (The Williams and Wilkins Co., Baltimore-2, Maryland, U.S.A.), 1960. Pp. xi + 230. Price \$ 5.25.

Space Trajectories—A Symposium Sponsored by the American Astronomical Society. Edited by the Technical Staff of the Radiation Inc. (Academic Press, New York-1), 1960. Pp. x + 298. Price \$ 12.00.

SCIENCE NOTES AND NEWS

Use of 'Reproduction Paper' for Printing Chromatogram

Sri. M. V. Dabholkar, French Institute, Pondicherry, writes: In the Ammonia paper method recommended by Idelman and Seshadri (*Curr. Sci.*, 1960, 29, 21), for the preparation of permanent record of chromatogram, the printing of the chromatogram should be done before the colours of the bands fade away. This is not possible when one is in need of many copies of chromatogram. In that case the use of Ammonia paper is not feasible. If, however, instead of Ammonia paper, the "Reproduction paper" (supplied by Kilburns and Co.) is utilized for printing the first copy of the chromatogram, the above difficulty would be solved. This print serves as the original chromatogram from which one can take as many copies as one wants and when needed.

It is, therefore, advisable to take the first print on the 'Reproduction paper' and subsequent copies on Ammonia paper by using the above print.

Solar High Voltage Electricity Generator

Sri. S. Parameswaran, Chartered Engineer, Bombay, writes: An easy and cheap method of generating electricity in large amounts making use of Solar Radiation has been developed and is being put to exacting tests. The heat generated by concentrating the Solar Radiation is utilized to vapourize water contained in a spherical chamber into steam. This chamber is held by two supports in such a way that it can rotate freely of its own accord due to the torque developed by the escape of steam through the two narrow outlets provided diametrically opposite. This torque is transferred to the armature of a High Voltage Alternator, generating electricity. The method which is found to be encouraging involves only simple techniques and can be installed in any open locality availing of the sun's radiation there.

Award of Research Degrees

Andhra University has awarded the D.Sc. Degree in Physics to Sri. J. Sobhanadri for his

thesis entitled "Calculations from Dipole Moments of Some Halides of Group V Elements and Studies from Microwave Measurements on Relaxation Times" and D.Sc. Degree in Pharmacy to Sri. K. Sambamurty for his thesis entitled "Chemical Investigation of Some Medicinal and Poisonous Plants of India".

Calcutta University has awarded the D.Sc. Degree in Botany to Mrs. Archana Sharma for her thesis entitled "Structure and Behaviour of Plant Chromosomes in Relation to Speciation, Differentiation and Chemical Treatment" and the D.Phil. Degree in Botany to Sri. Arya Kumar Bal for his thesis entitled "Chromosomes Susceptibility to Different Compounds".

Punjab University has awarded the Ph.D. Degree in Physics to Sri. B. D. Sharma for his thesis entitled "Studies of Some Structure Sensitive Characteristics of Solids (Metals and Alloys) using Recent Optical Techniques", and Ph.D. Degree in Botany to Sri. M. L. Banerji for his thesis entitled "Contribution to the Flora of East Nepal".

Raman Chair in Physics in the Madras University

The Madras University has decided to institute a professorship—the Raman Professorship of Physical Sciences—as a tribute to the great work that Sir C. V. Raman has been doing. This was announced by Sir A. Lakshmanaswamy Mudaliar, Vice-Chancellor of the University of Madras, on the occasion of the Twenty-sixth Annual Meeting of the Indian Academy of Sciences held under the auspices of the Madras University, which he inaugurated on December 27, 1960.

Lady Tata Memorial Trust Scientific Research Scholarships

The Trustees of the Lady Tata Memorial Trust are offering six scholarships of Rs. 250 each per month for the year 1961-62 commencing from 1st July 1961. Applicants must be of Indian nationality and Graduates in Medicine or Science of a recognised University. The scholarships are tenable in India only and the holders must undertake to work wholetime under the direction of a scientist of standing in a recognised research institute or Laboratory on a subject of scientific investigation that must have a bearing either directly or indirectly on the alleviation of human suffering from disease. Applications must conform to the instructions drawn up by the Trust and should reach by March 15, 1961. Candidates can obtain these instructions and other information they desire,

from the Secretary, the Lady Tata Memorial Trust, Bombay House, Bruce Street, Fort, Bombay-1.

The Institute of Physics and Physical Society Awards

The Council of the Institute of Physics and the Physical Society has made the following Awards: The Duddell Medal to Dr. J. B. Adams, the Director-General of C.E.R.N. (the European Organization for Nuclear Research). The Charles Vernon Boys Prize to Professor A. W. Merriam of the University of Liverpool for his distinguished research in experimental physics. The Charles Chree Medal and Prize to Dr. S. E. Forbush of The Carnegie Institution of Washington for his distinguished work on the cosmic radiation.

British Industrial Biological Research Association

A new research organisation—the British Industrial Biological Research Association—has been formed to study the possible effects upon health and to ensure the harmlessness of substances which may be ingested in food, drink and cosmetics.

The Association's main object is the establishment of a biological research station for investigating the effect of the many substances used in food manufacture, either as processing aids or for flavouring and colouring food as well as those which may get into food from pesticides, from plant used in food manufacture, from packaging materials, or from utensils. Although some of the larger companies in the food and chemical industries have their own research facilities, until now there has been no national industrial organisation in this country with responsibility for work of this kind.

There is a lack of data on the effect of these substances on health, particularly when they are ingested in small quantities over a long period of time. Further development of test methods using experimental animals is also needed. Results related to research in other establishments throughout the world will be studied and interpreted for members as part of an advisory and information service.

The temporary headquarters of the British Industrial Biological Research Association Ltd., are at 11, Green Street, London W. 1.

Symposium on Indigenous Drugs

Under the joint auspices of the Indian Pharmaceutical Association (Maharashtra State Branch), the Indian Medical Association (Bombay Territorial Branch) and the Bombay Medical

Union, a Symposium on Indigenous Drugs will be held on Sunday, the 26th February 1961, in Bombay, to focus the attention of the medical practitioners and pharmaceutical chemists on some promising vegetable drugs which could come into wider use. Eminent pharmacologists and clinicians connected with researches on indigenous drugs will be participating in the symposium.

Symposium on Ecological Problems in Tropics

A Symposium on "Ecological Problems in Tropics" will be held during the Annual Session of the National Academy of Sciences at Allahabad on 3rd and 4th February 1961. Abstracts of papers (about 200 words) should be sent to the Convener, Dr. G. S. Puri, Director, Central Botanical Laboratory, Allahabad.

Atmospheric Pollution—Smog Law in California

With the passage of the Auto Smog Law on 5th April 1960, California became the first State to take legislation measures against pollution of the atmosphere by the automobile. The Bill, which became effective in July, requires control devices on all new cars throughout the State. The devices are estimated to be capable of reducing the emission of hydrocarbons and oxides of nitrogen from the automobiles by 90% and emissions of carbon monoxide by 70%. A control measure prohibiting the sale for motor fuel of gasoline having a Bromine number of more than 30 is expected to reduce the amount of eye-irritation experienced by residents of the Los Angeles Basin.—(*Bull. Amer. Met. Soc.*, 1960, 41, 574).

High Resolution Raman Spectroscopy of Gases

Stoicheff, Rao and Turner have reported (*Can. J. Phys.*, 1960, 38, 1516) the results of analysis of the pure rotational Raman spectra of gaseous Zinc-, Cadmium-, and Mercury-dimethyl molecules, and of their fully deuterated compounds, photographed in the second order of a 21-ft. grating with a reciprocal linear dispersion of $6.7 \text{ cm}^{-1}/\text{mm}$. The spectra are typical of symmetric top molecules and consist of many evenly spaced rotational lines having a separation of about 0.45 cm^{-1} . This is consistent with the linear C-metal-C structure. From the rotational constants of the analyses the following metal-carbon bond lengths have been obtained: $\text{Zn-C} = 1.929 \text{ \AA}$, $\text{Cd-C} = 2.112 \text{ \AA}$, and $\text{Hg-C} = 2.094 \text{ \AA}$.

About 50-60 rotational lines have been measured in each of the six rotational spectra which extend to only about 30 to 40 cm^{-1} from the exciting line $\text{Hg } 4358$. The separation

(0.36 cm^{-1}) of the rotational lines in the spectra of $\text{Hg } (\text{CD}_3)_2$ and $\text{Cd } (\text{CD}_3)_2$ is the smallest so far measured in a Raman spectrum. Results show that the experimental techniques employed are satisfactory for the study of molecules having moments of inertia up to $300 \times 10^{-40} \text{ g.cm}^2$.

Hydrogen Maser

Scientists at Harvard University have used a hydrogen maser to make a clock which promises to be 100,000 times as accurate as even the atomic clocks. The device uses a paraffin-lined quartz bulb to keep high-energy hydrogen atoms from dropping to lower energy levels. Experiments have shown that one high-energy atom can endure some 10,000 bumps, giving it a high-energy lifetime of about a second. The bulb is used as the source of 21 cm. radiation of great stability and purity of tone. Its nearly perfect monotone promises to make the maser clock a new standard for time frequency. The device is expected to be accurate to one part in 10^{15} .—(*Electronics*, October 28, 1960).

Radio Waves from Saturn

Professor Fred T. Haddock, Head of Radio Astronomy, University of Michigan, reported to the 13th General Assembly of the International Scientific Radio Union, the results of the findings on the detection and measurements of radio waves from Saturn. The measurements were made with the 85 ft. radio telescope through the use of a new and highly sensitive ruby maser amplifier developed by one of the laboratories of the Michigan University.

The naturally generated radio waves are emitted from various depths in the planet's atmosphere whose temperature was found to be about 100° K . Precise measurements at a number of frequencies will make it possible to obtain knowledge about the temperature and density of the rings of Saturn and about the distribution of gases in the planet's atmosphere.—(*J. Frank. Inst.*, 1960, 270, 426).

Fish from a Depth of 7,580 Metres

Research recently conducted at the Kurile-Kamchatka depression in the Pacific by a scientific expedition of the USSR Academy of Sciences on Board the Vityaz succeeded in obtaining a hitherto unknown fish from a depth of 7,580 metres. There were no scales on its colourless body. The absence of light in the ocean depths affected the structure of its eyes: they were jelly-like and the size of a pin head. At present this antique is in the collection of

the Zoological Institute in Leningrad.—(USSR News).

Micro-Elements in Human Body

About ten elements, such as carbon, hydrogen, oxygen, nitrogen, potassium, magnesium, sulphur and iron, constitute 99% of the weight of plants and animals. A thorough chemical analysis of the cell has shown that about 50 other elements are contained in the remaining 1%. These micro-elements present in such small quantities exert a great influence on the vital activities of various organisms.

The results of the experiments on plants were amazing. Tests conducted with various micro-elements showed that micro-fertilizers cannot be replaced by the usual fertilizers (nitrogen, phosphorus and potassium). The manganese sludge or waste left over during the process of manganese-ore enrichment, deposits of which amount to many millions of tons, is found to be one of the most valuable and very interesting micro-fertilizers. In the Kharkov region (Ukrainian SSR), for instance, the addition of 150 kilograms of the sludge per hectare increased the crop yield of sugar-beet by 30%.

The role played by the micro-elements in human cells is no less interesting. Entering the organism together with food, they go to form the ferments, hormones and other substances controlling vital processes in human body. They are also constituents of many vitamins important for the organism.

About 40 to 45 various micro-elements were revealed in the human body. Even the rarest radium is present in it, deposited in the brain substance. Till recently investigations were limited to copper, cobalt, manganese, zinc, molybdenum, iodine, strontium, vanadium and iron. It appears that copper not only participates in the make-up of proteins, but may even form the copper-protein compounds. Organic substances rich in copper have already been discovered in the blood erythrocytes, liver and milk. Experiments have demonstrated that fibrin, an important part of the blood, is a chemical "cobalt protein".

Indications are that micro-elements may play an important role in the treatment of cancer. It is considered that cancer may be successfully treated by hormones inhibiting the growth of

cancer tumours. It is also known that the micro-elements have a very strong effect on the formation of such hormones. If the organism of a cancer patient lacks the micro-elements which promote the development of such hormones it may lose the power of self-protection. However, it may evidently be helped by administering the deficient hormones.—(USSR Information).

The Locust

The locust is probably the longest migrating insect on earth. It can travel up to 100 miles a day and can go on for six or seven days—that is six or seven hundred miles practically without eating. It has a wide range of tolerance to temperatures and at 115° F., feels quite happy and at home when other insects are beginning to expire from the heat. It can also withstand the low night temperatures that come in the desert. In fact, the desert locust enjoys the heat and dryness of the atmosphere of the desert, and needs the moisture to be found in the soil to hatch its eggs. It has fewer enemies than any other creature. It has an extremely interesting life-cycle consisting of two phases. In the first, it lives a solitary existence. Its hoppers are yellow or greenish-yellow in colour which gives them excellent camouflage but on multiplication they change, becoming gregarious and taking on a bold yellow and black colour. As a young insect it is sedentary by nature, lazy and wants to hide. As soon as it gets together with other locusts, it becomes gregarious, bold and very active.

We were interested to find out what made the solitary green hoppers of locusts turn black when they met other hoppers. In one experiment we put two green hoppers in a glass and the effect socially was that they both became black. When we separated them they reverted to their original green. As a further test we put a hopper in a space surrounded by mirrors and the sight of himself caused him to jump excitedly and eventually change colour. It became obvious that the black pigment was due to muscular activity, a conclusion which was further supported by an experiment in keeping the hopper on the move by artificial means, as a result of which the creature turned black—(Dr. Taskir Ahmed at the Rome Meeting of FAO on "Desert Locust").

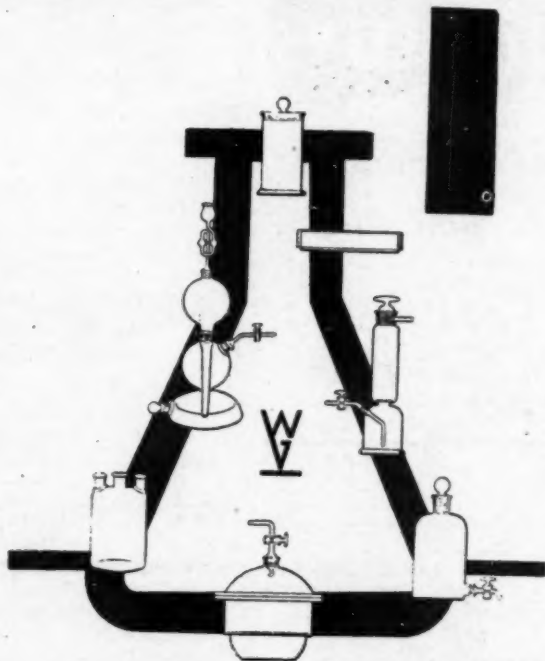
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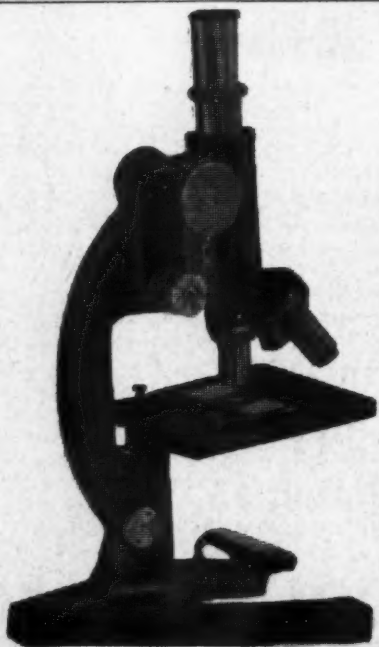
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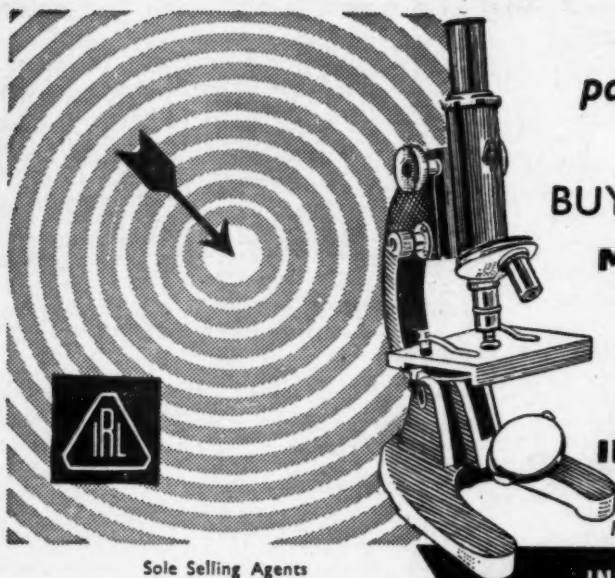
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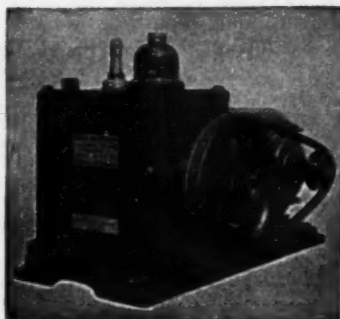
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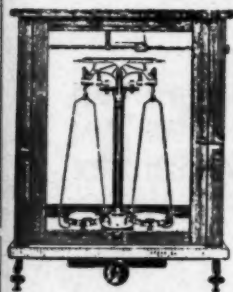
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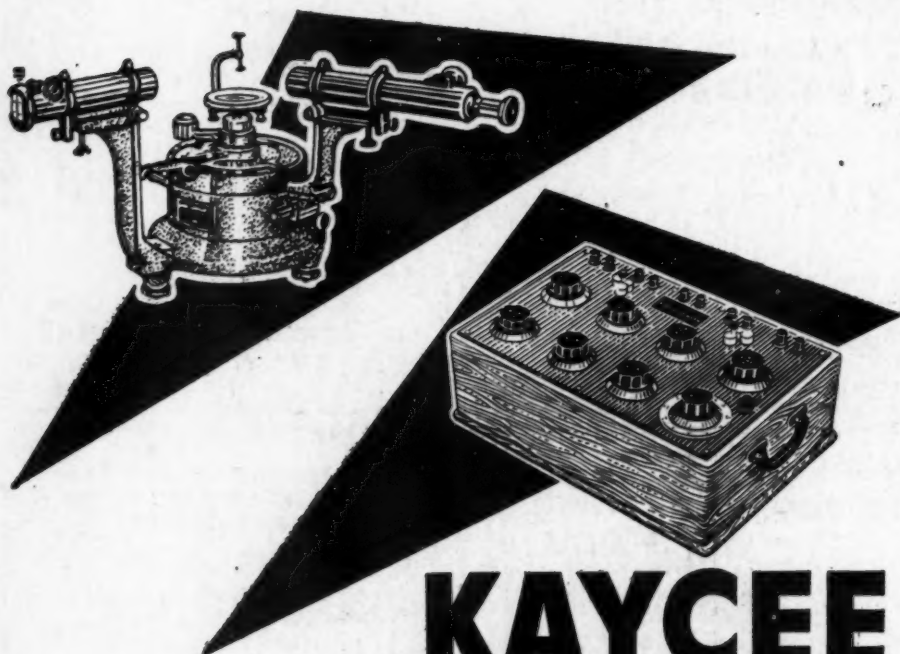
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